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Part-time farming is increasing in importance. The 1959 census indicates that approximately 17 percent of the farmers in Illinois worked off of their farms for 200 or more days. This compares with 13 percent in 1950 and only 7 percent in 1940. On such farms it is important to integrate the farming operation with the off-farm employment. The first article in this issue analyzes such integration on three sizes of farms in the extreme southern tip of Illinois — an area that has received attention in the Rural Areas Development program.

Public policy relating to land tenure in the United States has been strongly influenced by the ideal of farmland being owned and operated by farm families. This ideal has found expression in a number of public programs, including the Homestead Act passed in 1862. A century later, in a different setting, we are interested in the chances for a beginning farmer to become a full owner-operator. The second article describes the various tenure stages experienced by a group of McLean County farmers and gives an idea of the probability of achieving the goal of farm ownership.

An important deficiency in most price indexes is their failure to take adequate account of quality changes. Since most quality changes are improvements, it is likely that present indexes overstate the increases in "real" prices that have occurred. Quality improvements have occurred both in farm commodities and in the production items that farmers buy. In particular, improvements in farm power and machinery have been substantial in the past decade. The third article in this issue reports the results of adjusting the tractor price index for certain changes in quality.

Although the percent of Illinois farm operators that are tenants has declined from a 1935 peak, a large number (about one-third) presently rent all of the land they farm. The way in which costs and returns are divided between landlord and tenant on these farms has a substantial impact on the efficiency of resource use. Since local custom plays an important role in establishing lease provisions, we find that desirable lease adjustments do not occur rapidly. The fourth article suggests alternative means for making such an adjustment in the case of landlord investment in livestock facilities under crop-share leases.

The export market for U.S. agricultural commodities is important. In 1962 commodities representing approximately 15 percent of the cash receipts from farm marketings were exported. In terms of the nation's total commodity exports, agriculture accounts for one-fourth. The last article in this issue continues a series on analysis of the imports of agricultural commodities into the 17 countries of Western Europe. This article presents a separate analysis of the effects of certain key variables on the imports into Western Europe of three categories — food, beverages and tobacco, and oils and fats.

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Labor Utilization on Farms in Southern Illinois[1]

L. A. DUEWER

THE LABOR RESOURCE HAS RE-ceived considerable attention in recent years, both in the economy as a whole and in the agricultural sector. The rate of unemployment has been a matter of national concern. Unemployment, under-employment, income levels, and other measures were considered in delineating areas for the Rural Areas Development program. The study reported in this article is concerned with eight Rural Areas Development counties in the southern tip of Illinois: Alexander, Hardin, Jackson, Johnson, Massac, Pope, Pulaski, and Union.

Labor available on farms may be used directly in agricultural production or it may be utilized in nonfarm job opportunities. The use of labor in off-farm employment, while agricultural production is continued with the remaining labor, is called part-time farming. This type of labor use is becoming more and more common in most sections of the country. Alternative means for increasing employment for individual farmers include increasing the size of farms and intensifying the operations on present acreages.

This article reports the results of a study of the utilization of farm labor in the selected southern Illinois counties. The study had the following objectives:

1. To estimate the effects on income of farmers working full time off the farm during one, two, three, or four seasons of the year: spring (March through May), summer (June through August), fall (September through November), and winter (December through February).

2. To study the effects of farm size on labor utilization and income.

3. To determine ways to intensify farm operations in order to increase income by more efficiently using available labor and other resources.

Relevant Area Characteristics

The area studied is predominantly rolling with light-colored soils that are low to medium in productivity and have serious erosion problems. This makes the area adapted mainly to rotations that include a high proportion of grasses and legumes. Some of the land should be used only for permanent pasture or timber. At present 22 percent of the land in farms is in timber.

Although there is great range in farm size in the area, there is a preponderance of smaller farms; 21.9 percent of the total farms are smaller than 50 acres, 21.7 percent are between 50 and 100 acres, and 25.7 percent are between 100 and 180 acres. This area of the state has a higher percentage of farm operators who own their farms, a lower value of land and buildings per acre, and a lower value of all farm products sold per farm than the state as a whole.

The area has a surplus of labor, and a problem of underemployment exists in agriculture. Although farmers might

[1] A more detailed discussion is reported in L. A. Duewer, "An Analysis of Labor Resources in Selected Southern Illinois Rural Areas Development Counties," unpublished Master's thesis, University of Illinois, 1962.

possibly earn more total income by working off the farm, it is often difficult for them to find employment. The marked migration out of the area is shown by a decrease of 17.4 percent in the total population between 1940 and 1960.

Table 1. — Land Use per Farm

Farm	Crop-land	Woodland pastured	Woodland not pastured	Total woodland	Other pasture	House, barn, roads, lots, etc.
			(acres)			
Average (167.7 acres)[a]	108.6	10.5	26.1	36.6	11.5	11.0
160–acre	104.0	....	....	31.0	15.0	10.0
40–acre	26.0	....	....	8.0	3.0	3.0
520–acre	345.0	....	....	95.0	50.0	30.0

[a] This is the average size of present farms in the area.

Table 2. — Identification of Situations and Farm, Off-Farm, and Total Returns of Each Situation[a]

Situation number	Seasons worked off the farm				160–acre farm	40–acre farm	520–acre farm	Rotation land may be rented at $5 net per acre	Rotation land may be rented at $8 net per acre
	Spring	Summer	Fall	Winter					
1	X	X	X	X	X				X
2	X	X	X	X	X				
3	X	X	X	X	X			X	
4	X	X	X	X	X			X	
5					X				X
6	X				X				X
7		X			X			X	
8				X	X			X	
9	X	X			X			X	
10	X			X	X			X	
11		X		X	X			X	
12		X	X	X	X				X
13	X	X	X	X	X				X
14	X	X	X	X	X			X	
15	X	X	X	X	X			X	
16	X	X	X	X		X			X
17	X	X	X	X		X		X	
18	X	X	X	X		X			
19						X		X	
20		X				X		X	
21				X		X		X	
22			X	X		X		X	
23	X		X	X		X		X	
24							X	X	
25							X		X
26							X	X	
27							X		
28				X			X	X	
29		X		X			X	X	
30	X	X	X	X			X	X	
31	X	X	X	X	X				
32	X	X	X	X	X				
33	X	X	X	X		X			
34	X	X	X	X		X			
35	X	X	X	X			X		
36	X	X	X	X			X		

[a] Optimum farm program returns were obtained by linear programming for the first 30 situations and by budgeting for the last six.

Method of Analysis

Three sizes of hypothetical farms were used in this study. A 160-acre farm was used because it approximates the average size of farm in the area (167.7 acres). A 40-acre farm was chosen to represent the large number of small farms in the area where the greatest excess-labor problem is found. A 520-acre farm was used to study the effects of larger size in relation to the aspects considered. The land use assumed for the three representative farms as well as the actual use on the average farm is given in Table 1. Land listed under total woodland acres was assumed to be in permanent forest in the plans.

Plans for 36 different situations were developed (Table 2). In the first 30 situations linear programming was used to determine optimum farm plans while varying labor and other restrictions on the plans. The use of this technique provided for the selection of the farm plan that maximized profits to available land, labor, capital, and management. The plan was also required to be consistent with certain restrictions on re-

Dairy removed as enterprise possibility	Son included in labor available	Price of milk changed from \$3.80 to \$3.30 per hundred	Total farm rented out	Total farm sold	Farm returns to land, labor, capital, and management	Off-farm work returns	Total returns
					\$3,463	\$3,528	\$6,991
					2,798	3,528	6,326
X					2,953	3,528	6,481
		X			2,935	3,528	6,463
					7,273	.....	7,273
					4,475	832	5,307
					4,556	832	5,388
					4,083	832	4,915
					3,914	1,663	5,577
					3,251	1,663	4,914
					3,254	1,663	4,917
					3,502	2,495	5,997
	X				5,142	3,528	8,670
	X				4,926	3,528	8,454
X	X				4,413	3,528	7,941
					2,771	3,528	6,299
X					2,267	3,528	5,795
					2,754	3,528	6,282
					5,675	.....	5,675
					3,593	832	4,425
					3,902	832	4,734
					3,145	1,663	4,808
					2,850	2,495	5,345
					8,472	.....	8,472
					9,470	.....	9,470
X					8,088	.....	8,088
					7,337	.....	7,337
					5,776	832	6,608
					4,906	1,663	6,569
	X				7,111	3,528	10,639
			X		1,111	3,528	4,639
				X	1,192	3,528	3,760[b]
			X		349	3,528	3,877
				X	600	3,528	3,168[b]
			X		3,480	3,528	7,008
				X	3,016	3,528	5,584[b]

[b] Off-farm housing costs of \$960 per year are subtracted.

source use as stipulated by the particular situation.[2] The last six situations, which included selling and renting the farm, were evaluated by conventional budgeting.

The solutions obtained in all cases were for the farm after all adjustments were made. The transition from the present farm plan to the optimum farm plan was not studied. The linear programming coefficients used for the crop and livestock activities are grouped and summarized in Table 3 to indicate the input-output relations assumed.

Possibility of Off-farm Work

Farm returns, off-farm work returns, and total returns are listed for each farm situation in Table 2. The particular assumptions for each situation are also given. For example, situations 1 and 2 are alike except that renting out of rotation land at $8 per acre is considered as an alternative in situation 1 but not in situation 2. Differences in the returns among the various situations permit an evaluation of the plans and assessment of the effect on income of changes in certain elements in the situation.

As might be expected, a comparison of farm profits of the optimum plans for each of the various situations indicates that as more time is spent working off the farm, income from the farm business lessens because the reduction in amount of labor available for farm use results in a smaller farm business. Work on the farm is assumed to be done before and after "normal" working hours and on weekends. The returns from off-farm work naturally increase as the amount of work off the farm increases. Wages of $1.75 per hour were assumed if all four seasons were worked off the farm and $1.65 if only one, two, or three seasons were worked off the farm. If the operator is indifferent regarding source of returns, maximization of *total* returns appears to be the best criterion for evaluating off-farm work. There are, of course, other factors that enter into an individual farmer's decision regarding off-farm work to supplement farm income.

Situations 31 through 36 are the renting and selling situations in which a farmer does no farming but works four seasons off the farm. The proceeds of the land sold were assumed to be reinvested in nonfarm investments. Total returns are smaller for each size farm than the programmed situations in which farming is an alternative. This indicates that, under the off-farm wages assumed, it is better to remain on the farm full time or part time than to discontinue farm work entirely.

Situations 13, 14, 15, and 30 include four seasons of off-farm work with a son of high school age adding labor to the farm. In those situations which can be compared (1 and 13, 3 and 15) the difference in returns indicates that the extra labor of the son is used to advantage.

A comparison of situations 1 through 12 (the remaining 160-acre farm situations) indicates that the maximum total returns are $7,273 in situation 5, which utilizes full-time on-farm work. The next highest labor situation choice for the 160-acre farm is situation 1 with total returns of $6,991. This situation provides four seasons of off-farm work for the operator. The situations where one, two, or three seasons are worked off the farm show considerably lower total returns.

[2] The linear programming technique is discussed in several sources, including: Kenneth E. Boulding and W. Allen Spivey, *Linear Programming and the Theory of the Firm,* The Macmillan Co., 1958; Robert Dorfman *et al., Linear Programming and Economic Analysis,* McGraw-Hill Book Company, 1958; and Earl O. Heady and Wilfred Candler, *Linear Programming Methods,* Iowa State University Press, 1958.

Table 3. — Summary of Livestock and Crop Coefficients

Enterprise or activity	Unit	Annual labor required	Pasture use	Corn fed	Hay fed	Oats fed	Other costs	Selling price	Yield or production
		(hours)	(acres)	(bu.)	(tons)	(bu.)			
C-W-L-L-L-L									
160-acre farm	1 acre	4.9					$18.17	Corn $.90 bu.	Corn 60 bu. per A.
40-acre farm	1 acre	5.4					18.79	Hay $13.50 ton	Wheat 24 bu. per A.
520-acre farm	1 acre	4.0					17.78	Wheat $1.72 bu.	
C-O-L-L-L-L									
160-acre farm	1 acre	4.9					18.03	Corn $.90 bu.	Corn 60 bu. per A.
40-acre farm	1 acre	5.4					18.66	Hay $13.50 ton	Oats 48 bu. per A.
520-acre farm	1 acre	4.0					17.65	Oats $.58 bu.	
O-L-L-L-L-L									
160-acre farm	1 acre	3.7					15.48	Oats $.58 bu.	Oats 63 bu. per A.
40-acre farm	1 acre	4.0					15.65	Hay $13.50 ton	
520-acre farm	1 acre	3.3					15.39		
Pulpwood production	1 acre	1.55					2.74	$2.50 for stumpage	32 cord at 20 yr.
Feeder-pig production[a]	2 litters	28.0	.05	52		16	64.26	Pigs $10 per head Sows $12 cwt.	7 pigs raised per litter
Fattening hogs from weaning									
Spring	1 pig	20.0	.04	11		1.7	13.73	$14.50 cwt.	Sell at 215 lb.
Fall	1 pig	21.0		11		1.7	14.63	$14.50 cwt.	Sell at 215 lb.
Beef herd[a]									
Rotation pasture	1 cow	20.0	1.7	4	.8	3	12.75	Steer calves $24 cwt. Heifer calves $22 cwt.	90 percent calf crop Steer calves 440 lb. Heifer calves 420 lb.
Permanent pasture	1 cow	20.0	2.1	4	.8	3	12.75	Steer calves $24 cwt. Heifer calves $22 cwt.	90 percent calf crop Steer calves 440 lb. Heifer calves 420 lb.
Feeder cattle, pasture fed	1 feeder	18.0	1.0	48	.5	6	114.99[b]	$23.20 cwt.	600 lb. beef added
Sheep flock[a]									
Rotation pasture	1 ewe	7.0	.16	1.75	.1	3	6.30	Wool $.60 per lb. Lambs $18.50 cwt. Ewes $6 cwt.	Wool 9 lb. Lamb crop 100 percent Lambs sold at 90 lb.
Permanent pasture	1 ewe	7.0	.2	1.75	.11	3.5	6.30	Wool $.60 per lb. Lambs $18.50 cwt. Ewes $6 cwt.	Wool 9 lb. Lamb crop 100 percent Lambs sold at 90 lb.
Dairy herd[a]									
Rotation pasture	1 cow	120.0	1.7	50	1.2	16	86.00	Milk $3.80 cwt. Calf $20 cwt.	Milk 9,600 lb. 90 percent calf crop Vealers sold at 200 lb.
Permanent pasture	1 cow	120.0	2.1	50	1.2	16	86.00	Milk $3.80 cwt. Calf $20 cwt.	Milk 9,600 lb. 90 percent calf crop Vealers sold at 200 lb.

[a] Livestock production enterprises include replacement stock.
[b] Includes cost of feeder.

Maximum total returns of $6,299 for the 40-acre representative farm are attained in situation 16, with four seasons of off-farm work. Total returns are $624 less in situation 19, with full-time on-farm work. All situations in which four seasons of off-farm work are utilized and the situation where full-time on-farm work is utilized show greater returns than situations 20, 21, 22, and 23, where one, two, or three seasons are worked off the farm.

For the 520-acre farm, the maximum total-returns situation (if the one with the son's added labor is excluded) is situation 25, with returns of $9,470. Situations 24 and 25 are the same except for the rent on rotation land. When situation 24 is compared with situations 28 and 29, lower returns are again found when only one or two seasons are worked off the farm. A situation was not included in which the operator worked off farm for four seasons with this size of farm.

For the 160- and 520-acre farms, total returns were maximized when the operator worked full time on the farm, and for the 40-acre farm when he had four seasons of off-farm work. Thus the changing from four seasons of off-farm employment to full-time on-farm employment becomes profitable, under our assumptions, somewhere between 40 and 160 acres.

If the differences between the full-time on-farm and the four-season off-farm labor situations on each of the 40- and 160-acre farms are added, $906 is obtained ($282 from the 160-acre farm and $624 from the 40-acre farm). These differences are between situations 1 and 5 on the 160-acre farm and 16 and 19 on the 40-acre farm.[3] The 160-acre farm represents 31 percent of the total difference and the 40-acre farm contributes the remaining 69 percent. Assuming a linear relationship, the two labor situations would be equally profitable at a point about two-thirds of the acreage difference between 40 and 160 acres, or at 120 acres. The recommendation that follows is that farm operators with less than 120 acres should, with the off-farm wages assumed, strongly consider the possibility of working four seasons off the farm along with part-time farming. It is not recommended that farm operators with acreages above 120 acres avail themselves of off-farm work, at least not on a full-time basis for one, two, three, or four seasons of the year.

Working off the farm one, two, or three seasons of the year was found unfavorable for this Southern Illinois area primarily because the livestock enterprises found in the optimum solutions (Table 4) utilize labor fairly evenly throughout the year. When one, two, or three seasons were worked off the farm, the remaining labor restricted the size of the enterprises and so there was unused labor in the other seasons.

Effects of Farm Size

A partial analysis of effects of farm size can be made by comparing the farm returns indicated in Table 2 and the optimum farm programs in Table 4 for selected situations. First, the recommendation that farmers on farms of less than 120 acres should work off the farm suggests that if a farmer does not want off-farm employment, his farm should be 120 acres in size or larger.

A comparison also shows that as the size of the farm increases, greater profits are made. This is due in large part, however, to the renting out of rotation land rather than to an increase in the size of the actual farm business. Some of the increase in profits results from an as-

[3] These situations are the same, except for farm size, with the exception of situation 19, which has the possibility of renting rotation land set at $5.00 rather than $8.00.

Table 4. — Optimum Solutions for Selected Situations

Enterprise or activity[a]	Situations[b]									
	1	4	5	7	8	13	16	19	25	26
C-W-L-L-L-L rotation	...	75	52	...	19	29	...	...	12	190
C-O-L-L-L-L rotation	...	...	...	18	...	...	...	...	...	...
O-L-L-L-L-L rotation	9	...	...	...	...	...	21	26	...	...
Pulpwood production	...	...	...	...	...	...	...	...	...	...
Feeder-pig production	...	...	...	...	61	...	...	63	...	...
Fattening hogs										
Spring	...	3	...	...	246	...	...	...	...	19
Fall	...	...	...	144	...	...	...	78	...	...
Beef herd										
Rotation pasture	...	...	...	...	...	...	...	...	...	...
Permanent pasture	...	7	...	...	7	...	...	...	...	24
Feeder cattle										
Pasture fed	...	50	...	...	...	...	...	...	...	126
Sheep flock										
Rotation pasture	...	...	...	...	...	...	...	...	...	...
Permanent pasture	...	...	...	...	...	...	...	...	...	...
Dairy herd										
Rotation pasture	4	...	20	7	...	11	10	11	5	...
Permanent pasture	7	...	7	7	...	7	1	1	24	...
Rent out rotation land	95	29	52	86	85	75	5	...	333	155
Hiring labor	96	96	96	96	96	96	96	96	240	240
Borrowing cash	...	...	...	1,200	1,200	...	...	...	...	1,882
Buying corn	575	1,716	813	2,115	5,733	637	586	4,730	1,311	4,476
Buying hay	14	31	34	17	6	22	14	15	34	82
Buying oats	90	327	443	327	1,421	296	...	1,059	459	863
Selling oats	...	...	...	...	...	...	34	...	...	...
Selling wheat	...	300	209	...	77	115	...	...	50	760
Labor unused in spring	...	...	...	429	99	...	...	...	...	...
Labor unused in summer	2	...	21	...	200	371	...	153	34	...
Labor unused in fall	4	...	18	332	313	8	...	...	21	...
Labor unused in winter	...	...	...	174	...	...	...	25	...	...

[a] All livestock and crop enterprises are included that were alternatives in the programming model, but the other activities were broken down more completely in the model and others were also included.

[b] The situations correspond to those in Table 1. Land usage is on the acre basis, livestock on the animal basis, crops on the bushel basis, hay on the ton basis, and labor on the hour basis.

sumption that as farm size increases, more operating cash is available, more hired labor is available, and certain efficiencies are built into the rotation processes. Since considerable land is rented out on the 160-acre and 520-acre farms, optimum farm size appears to depend on the availability of sufficient acreage to provide pasture for the livestock enterprises. As the area is not particularly adapted to grain production, it appears desirable to purchase feed rather than to increase the size of the farm to provide feed grains.

Labor was utilized almost completely on all farms with full-time on-farm work or four seasons of off-farm work, indicating that farms can be intensified to utilize available labor on smaller farms.

Guides to Farm Intensification and Management

Livestock and crop enterprises that were considered as alternatives in the programming model are listed in Table 4. Some of the items listed were included in the model on a seasonal basis. Table 4 lists only ten of the 36 situations and their optimum solutions, but these are representative of the others and provide an illustration of the programming results. In each situation the amount of labor hired in the solution is the maximum allowed by the programming model.

Intensification of farm operations in the southern Illinois area can best be achieved through increase of livestock enterprises. The particular enterprise or enterprises that maximize farm earnings

vary for different sizes of farm, among different farm operators, and in individual situations.

Among the livestock enterprises considered, a Grade A dairy herd appears to be the most profitable for all farm sizes, but is especially suited for the smaller farms. A smaller decrease in profits was found when dairy was removed from the 520-acre farm than from the smaller ones. The model used $3.80 per hundredweight for the price of milk in all situations except number 4 where $3.30 was used. A value of around $3.50 or lower would make dairying less profitable than other livestock enterprises at the prices used. Dairying is an enterprise requiring a high capital outlay, a large amount of work, and a desire for dairying by the operator, and should not be attempted without careful thought.

Feeder pig production is well adapted to the smaller farms as considerable labor is required and only a small amount of space. Sows and litters can be profitably produced along with dairy as in situation 19, or as the main livestock enterprise as in situation 8. This enterprise is becoming popular in the area and does not have to be carried out on as large a scale as in the two situations shown. The change of work off the farm from summer to winter changed the main enterprise from dairy to feeder pig production in situations 7 and 8 (both 160-acre farms). However, there is not a great difference in returns between these two plans.

Growing pigs to market weight may profitably utilize surplus labor on the farm. The optimum solutions indicate this enterprise is better adapted for the 40- and 160-acre farms and that it is profitable to purchase feed for their production.

It also appears profitable to purchase feed to produce feeder cattle. They appear to fit better into the organization of the larger farm, as shown by the 126 head specified in the optimum solution for situation 26.

A beef-cattle herd appears best adapted to larger farms, as such herds require relatively large quantities of pasture land in relation to the profit received. Beef and dairy do not appear at the same time in the optimum solution of any of the situations shown in Table 3 and are found together only in one other situation. Thus beef and dairy would generally not both be recommended on one farm; beef would be recommended for larger farms and dairy for smaller.

The production of sheep did not appear in the optimum solution of any of the situations. Therefore under situations which approximate the assumptions of the model, livestock enterprises other than sheep production would generally be recommended.

The farm business should be planned around the livestock enterprises. The cropping rotation should be planned to provide pasture for the livestock. The programming solutions show that only enough rotation land was used to provide pasture and a part of the feed for livestock. The C-W-L-L-L-L rotation appeared most often in the optimum plans with the O-L-L-L-L-L rotation next in frequency. The fact the C-O-L-L-L-L rotation appeared the least suggests that wheat is more profitable than oats in the area. The use of land for pulpwood production was found to be less profitable at present prices than the other rotation-land uses. It may, however, prove more profitable if pulpwood processing firms move into the area.

Labor is hired up to the maximum allowed in each situation. This means that farms can be intensified to utilize the labor available and still gain an adequate return for each hour's work. A comparison of situations 1 and 13 shows that seven cows were added to the dairy herd by the addition of the high school

age boy. In order for this to be a long-term plan, arrangements would need to be made to have the equivalent of this labor over a period of years.

Borrowing cash was not used in many cases in the optimum plans because the model assumed that the farmer had already arrived at his target of an optimum plan. Farmers in the area moving from their present farm situations to the programmed solutions would have to make substantial use of credit.

Summary and Conclusions

This examination of the utilization of available labor on farms in southern Illinois provided insights into three possible means by which labor may be employed more efficiently.

First, the alternative of working all four seasons off the farm combined with a farming operation was found desirable for farm operators with less than 120 acres. Renting or selling the farm to work off the farm was found less profitable than remaining a part-time farmer while working off the farm. This means more total hours of work, however. It was found that working one, two, or three seasons full time off the farm was less profitable than either year-round off-farm work, or full-time on-farm work.

A second method, increasing farm size, was found to be effective in increasing returns if the farms are smaller than 120 acres. For larger farms the amount of available labor could be fully utilized without increasing farm size. This indication was supported by the fact that the programmed solutions included renting out land on the 160- and 520-acre farms.

Third, the intensification of farms was found to be profitable, and various guides to intensifying farm businesses were determined from the programmed solutions. Dairying and production of feeder pigs were found best adapted to smaller farms and a beef herd and feeder cattle to larger farms. Growing pigs to market weight can help to utilize unused resources, especially on smaller farms. In this area of Illinois, farm intensification should stress the increase of livestock on the farm and put the cropland into a role of supporting livestock production.

Changes in Farm Tenure: A Markov Process Analysis[1]

F. J. REISS, R. C. HUGHES, and G. G. JUDGE

THE OLD "TENURE LADDER" IS no longer adequate as an analytical concept or as a descriptive device to measure and portray the dynamic character of farm tenure arrangements. The changing structure of farm firms is not simply a matter of enlarging the farm boundaries, nor are the additional changes confined to substitution of capital for labor and the adoption of new technologies.

Some fundamental changes are occurring in two important aspects of the farm firm: (1) the means by which operating rights in the expanded acreage of land are obtained and held, and (2) the personal-legal-economic allocation and exercise of the entrepreneurial-managerial function. Fee-simple (full owner with unrestricted possession) ownership of land and buildings is not always feasible where minimum acreages and real estate values associated with one man's labor average around 240 to 320 acres worth $100,000 to $200,000. Farm businesses employing a typical family

[1] A contribution of the Illinois Agricultural Experiment Station to North Central Regional Research Project NC-53.

labor supply of 15 to 24 months of labor can greatly exceed these values. Specialization in production has gone hand in hand with vertical integration, production under contract, accelerated investment in capital which substitutes for land and labor, and a professionalization of the management function.

One can cite individual cases and instances of the growth in farm operating partnerships, farm family corporations, and multiple-landlord, tenant-operated farms, but the available statistics on land tenure are generally confined to the traditional tenure categories, which do not sort out these groups. Even here the dynamic aspects of land tenure are only partially evident and certainly not adequately documented. Therefore, in order to shed some new light on tenure and tenure changes among farm operators, we applied the Markov chain technique to a sample of farm operators in McLean County, Illinois.

Since our interest is in the application of the Markov chain technique to the analysis of changes in farm tenure, a limited discussion will be given of the method.[2] First consider the following definition of a stochastic process: A stochastic process is an activity the outcome of which is predictable in probability terms but always subject to chance elements, thus rendering it impossible to predict with absolute certainty what the outcome will be at any given time.

If in any given sequence of actions the outcome of each action depends on some chance event, then any such sequence is called a stochastic process. The process is said to be finite if the possible outcomes are finite. Within this framework a Markov chain process is then defined if the outcome of a given action depends only on the outcome of the immediately preceding action and this dependence is the same at all stages (place in the sequence of actions). An equivalent definition given by Kemeny *et al.*, is as follows: "A Markov chain process is determined by specifying the following information. There is given a set of states or outcomes ($S_1, S_2 \ldots S_n$). The process is in one and only one of these states at a given time and it moves successively from one state to another. Each move is called a step. The probability that the process moves from S_i to S_j depends only on the state S_i that it occupied before the step. The transition probability P_{ij}, which gives the probability that the process will move from S_i to S_j is given for every pair of states. Also the initial starting state is specified at which the process is assumed to begin."[3]

The following example may help to further reflect the basic idea of a Markov chain process.[4]

"My favorite example of a Markov chain concerns a frog in a lilypond. The frog is sitting on one of a finite number of lilypads and will presently jump. He may go straight into the air and land back on his starting pad, or he may land on any other pad on the pond. The problem is to assign a probability to the frog's landing on any given pad, starting from any given pad. It is against the rules to land in the water, so there is a probability of 1 that he will land on some pad."

The possibilities are described for a pond containing only three pads.

"All told, there are nine possibilities, only three of which are pertinent to any

[2] For a more complete discussion of this procedure see G. G. Judge and E. R. Swanson, *Markov Chains: Basic Concepts and Suggested Uses in Agricultural Economics*, Department of Agricultural Economics, University of Illinois College of Agriculture, December, 1961, AERR-49.

[3] J. G. Kemeny et al., *Finite Mathematical Structures*, Prentice-Hall, New York, 1959, p. 148.

[4] Don Bostwick, "Yield Probabilities as a Markov Process," *Agricultural Economics Research* 14:51, April, 1962.

one situation. The frog must start somewhere, so the six possibilities that arise from his starting elsewhere are eliminated. According to our hypothesis, the frog does not jump at random. The probability of his arriving at pad 2, starting from pad 1, differs from the probability of arriving at pad 1, or pad 3. And the probability of arriving at pad 2, starting from pad 1, differs from the probability of arriving at this pad starting from pad 2 or 3. If he has enough jumps, the frog will eventually build a history including jumps from all three pads to all three pads. From these data, all manner of probability statements can be computed."

With this general notion of a Markov chain process, our application to the tenure problem is as follows: The admissible states or outcomes are defined by the tenure status of the farm operator. Thus for any point in time an operator will find himself in one of these states. The movement of an operator from one tenure class to the same or another tenure class from year t to year t + 1 is defined as a step. Given observations on the movement pattern of farm operators between tenure states, the transition probabilities, which give the probability that an operator will move from one tenure class to another, may then be estimated for every pair of states.

Thus the Markov chain process is a way of expressing the likelihood of change or movement from a given position or status, in terms of probabilities, to each of a given number of alternative positions, including that of remaining in place. The probabilities are based upon the frequency with which such changes have occurred in the past when observed as a sequence of events with each event assumed to be in some way related to and dependent on the immediately preceding status or event. For example, the probability that a farm operator will change to the status of a part-owner depends upon (1) his present tenure status, and (2) the frequency with which others have been able to make such changes in the past.

By looking at tenure status in this way, we are provided with a descriptive picture of how the tenure process has worked in the past, and given the transition probabilities we are able to say something of the tendencies of the system.

In a sense, the Markov process reveals more information and greater insights into age-tenure phenomena than does the agricultural ladder technique. Basically, the agriculture ladder consists of four steps: (1) a period of work, usually under age 14, when the individual is doing unpaid farm work, (2) a period when he is a hired laborer, (3) a period when he is a renter or tenant, and (4) a period when the ultimate goal, that of ownership, is achieved.[5]

A brief description of some problems involved in the use of this type of tenure ladder is taken from *Farm Ownership in the Midwest.*[6]

"The concept of a [tenure] ladder with a number of separate rungs rising [toward ownership] . . . implies that each successive group has higher tenure status than the preceding one. This concept is highly artificial and cannot be accepted without numerous reservations. . . . Another problem arises from the fact that the ladder concept implies constant progress towards ownership. In actual practice, many of the would-be owners who start out to climb the ladder never achieve their goal, while some of those who have climbed even as high as the top rung sometimes find themselves slipping to a lower rung."

[5] John F. Timmons and Raleigh Barlowe, *Farm Ownership in the Midwest,* North Central Regional Publication 13, Iowa Agricultural Experiment Station Research Bulletin 361, Ames, Iowa, June, 1949, p. 892.

[6] *Ibid.,* p. 892-893.

The Markov chain approach can overcome some of the limitations of the ladder concept. But even with the Markov chain, movement from tenure class to tenure class, as defined in the agricultural ladder, may not necessarily mean progress towards ownership. For example, movement from the tenant class to that of owner-operator may involve going into debt. Thus the ultimate goal of unencumbered owner-operatorship has not been attained.

The fact that some farmers slip from their rungs is handled easily in a Markov probability matrix. The observation of a "slip" from owner to tenant, following an earlier move from tenant to owner, would be reflected in the matrix by the transition probability for these two tenure classes. In addition, the transition probability matrix concisely describes movements among all the tenure groups. There is no need to select particular, most frequently used patterns of movement for analysis. All patterns are represented, but they are connected by a chain of probabilities rather than a step-like movement. In addition the future numbers of operators that will be in each tenure group may be estimated. Also, if the matrix of transition probabilities is regular, then the stationary or equilibrium state for the system may be obtained. This stationary state indicates the long-run tendency of the system if it is permitted to operate over a long period of time, i.e., the tenure structure that would obtain and remain stable. Although statistical for the group it is dynamic with respect to the individual operator since it permits movement between tenure classes. However for the equilibrium to be stable the number entering each class must be balanced by those leaving.[7]

[7] See I. G. Adelman, "Stochastic Analysis of the Size Distribution of Firms," *The Journal of the American Statistical Association,* 53:895-896, 1958, for further comment.

The Data

Given this brief look at Markov processes and some of the deficiencies in the old "agricultural ladder," let us proceed to a description of the McLean County study. What was needed as basic data was a relatively large number of observations of farm operator tenure status for each year in the series of years for an identified sample of farm operators. In other words, over a span of n years, through what tenure statuses did each operator move and how long did he remain in each status? In what status did he enter farming, and how was his age related to his tenure experiences?

Since accurate data of this kind require a recorded source, we turned to our records of farmers enrolled in the Illinois Farm Bureau Farm Management Service. McLean County was selected because it has what is probably the largest number of continuous farm records over time from a relatively small and homogeneous geographical area. Somewhat arbitrarily it was decided to limit the time period to the 13 years, 1948 through 1960, and to include only those farm operators who had at least three years of farm records within this period.

Unfortunately the available records did not always cover the entire time that these men had been farming during this period. Some farm operators had been farming for many years before joining the record-keeping service. Others dropped out of the record-keeping service but continued to farm. Some, of course, had continuous records throughout. Some started farming and others left farming during this period. It was necessary, therefore, to supplement the records in our files with information from field interviews on the unrecorded years in farming. The net result was a sample of 263 farm operators for whom we had a complete tenure history from 1948 to 1960 for 3,138 operator years.

Table 1. — Age Distribution of Operators in Sample and of All Operators in McLean County, 1959

Age of operator	Farms in sample		All farms in county reporting age of operator[a]	
	Number	Percent	Number	Percent
Under 25	4	1.6	6	1.9
25–34	65	25.8	487	15.4
35–44	94	37.3	835	26.4
45–54	63	25.0	756	23.9
55–64	21	8.3	653	20.7
65 or more	5	2.0	369	11.7
Total	252	100.0	3,161	100.0
Average age	42.3		47.9	

[a] Census of Agriculture, 1959.

There are some serious weaknesses in this sample for our present purpose. Not only was it not a randomly selected sample, but it contained some internal biases. Perhaps the most serious bias was our inability to get information on the older operators who were farming and keeping records in 1948 but who very soon after quit farming. This weakness is shown in the age distribution in the sample as compared with that for all farmers in McLean County as reported in the census of 1959 (Table 1). Tables 2 and 3 show how the sample compared in 1959 with all farms in size and tenure.

Table 2. — Farm-Size Distribution of Farms in Sample and of All Farms in McLean County 70 Acres or Larger, 1959

Class acres	Farms in sample		All farms 70 acres or larger[a]	
	Number	Percent	Number	Percent
70–99	5	2.0	222	7.9
100–139	3	1.2	205	7.3
140–179	23	9.1	532	19.0
180–219	28	12.1	347	12.3
220–259	44	17.5	455	16.2
260–499	125	49.5	894	32.0
500–999	24	9.5	140	5.0
1,000 or more	0	0	7	.3
Total	252	100.0	2,802	100.0
Average size	339.1		226.6	

[a] Census of Agriculture, 1959.

Table 3. — Tenure Distribution of Farms in Sample and of All Commercial Farms in McLean County, 1959

Tenure class	Farms in sample		All commercial farms in the county[a]	
	Number	Percent	Number	Percent
Full-owners	27	10.9	527	18.5
Part-owners	64	25.0	590	20.7
Managers	0	0	10	0.3
All tenants	161	64.1	1,728	60.5
All operators	252	100.0	2,855	100.0

[a] Census of Agriculture, 1959.

Joint-Operators

At this point we recognized a fourth tenure group, that of joint-operators, in addition to the three traditional groups, full owners, part-owners, and full tenants. This new tenure category was defined to include all farms on which the entrepreneurial-managerial function was shared by two or more persons. Most of the cases that fell into this category were father-son partnerships.

The census of agriculture has not yet recognized this tenure group. The census questionnaires have required that one person be designated as "the person in charge" and the tenure classification of the farm business has been the tenure status of this person in charge as either full-owner, part-owner, tenant, or manager. The farms that we have classified under joint-operators could have been similarly forced into the traditional classification. We did follow the "person-in-charge" technique in classifying the joint-operatorships into age groups according to the age of the person in charge.

The relation of age to tenure is graphically shown on page 14. By limiting the observations to the ten-year period 1948-1957, it was possible to set up this chart so that the terminal age of one group linked up with the beginning age of the next group, although with 10 years difference in time. The distribution of the

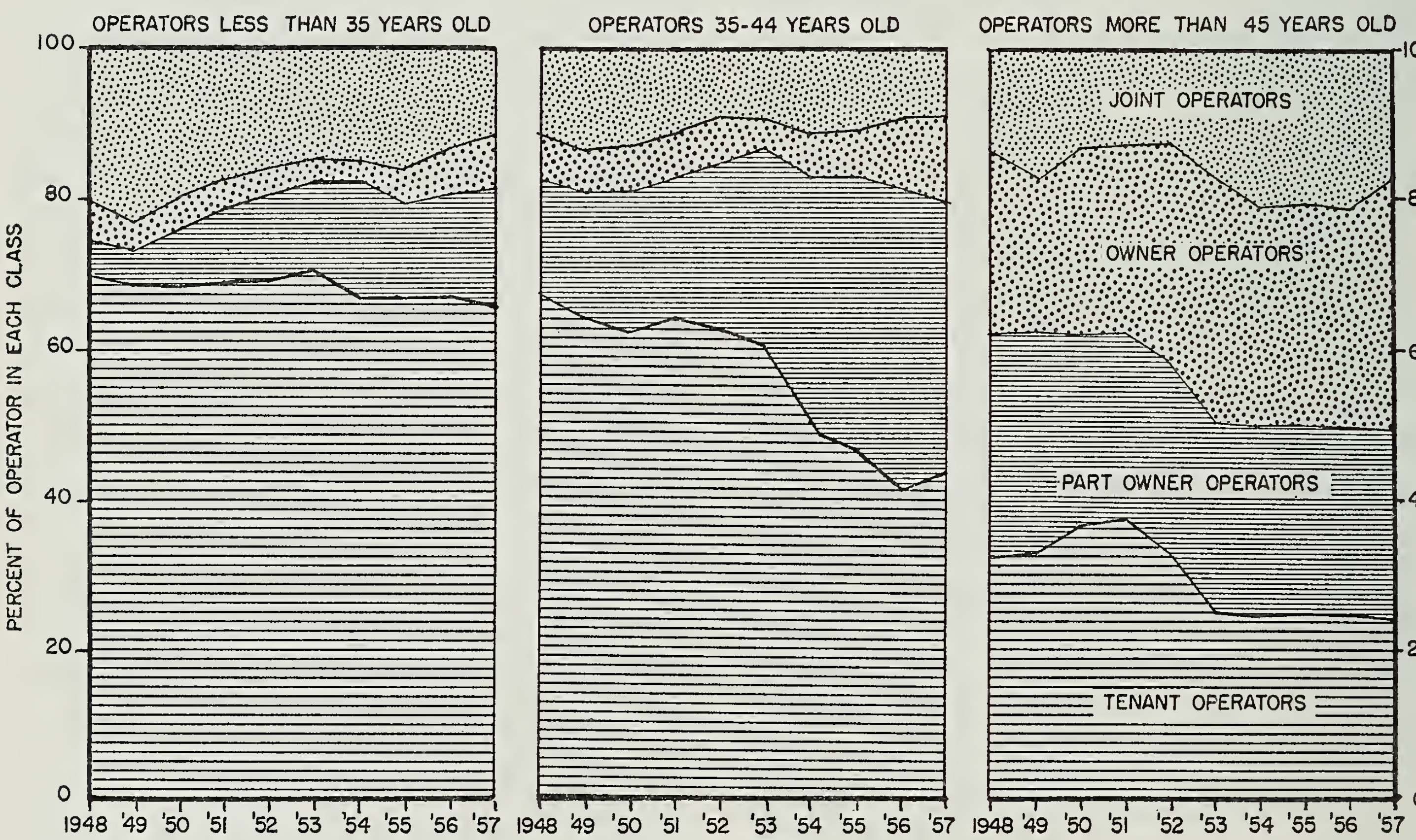
four tenure classes in each of the three age groups reveals the dynamic and cyclical character of tenure. Young farmers generally start as tenants in this part of Illinois, and shift to being part-owners, or start as joint-operators and shift into the tenant class. In the middle years the shift is primarily from tenants to part-owners, while in the older years the emphasis is toward owner-operation and back to joint-operatorships to effect the transition of a continuing farm business from one generation to another.

The Empirical Results

It is precisely the inadequacies of a graphic presentation such as that shown below to fully communicate the changes that occur that led to the application of the Markov process to our tenure information. Manipulation of the data involved setting up a complete matrix of 25 cells created by the cross-classification of the four tenure groups, plus an "entry pool," against the same tenure groups plus an "exit pool" (Table 4).

The entry pool was necessary to provide a source from which new farm operators are drawn, and the exit pool was added to provide a means for removing from the tenure matrix those who quit farming. The number of observations in the entry pool was arbitrarily set at a value that would equal the total potential entrants, or 100 percent, if the actual number who succeeded in getting started in farming amounted to 40 percent of the total. Other studies have shown that in the period under study here about 40 percent of all 15- to 19-year-old farm boys in the area succeeded in becoming farm operators.

In addition to the 60 percent of the potential entrants who failed to get into farming, the exit pool contains the number of farmers from the sample who actually left farming from 1948 to 1960. Table 4, of course, shows a much larger number entering than leaving because this matrix was restricted to those who were under 45 years old in 1948 or at time of entry subsequent to 1948. Thus



Percent of operators in four tenure classes, 1948-1957, by age of operator in 1948.

Table 4. — Matrix of Transition Probabilities for Farm Operators Under 45 Years of Age in 1948 or at Entry Into Farming

Tenure status in year t	Tenure status in year t+1					
	Exit pool	Joint-operator	Tenant-operator	Part-owner operator	Owner-operator	Total number of observations (operator-years)
Entry pool	.602	.102	.288	.008	.000	118
Joint-operator	.003	.898	.078	.015	.006	325
Tenant-operator	.006	.004	.970	.017	.003	1,514
Part-owner operator	.003	.011	.023	.944	.019	270
Owner-operator	.000	.010	.000	.073	.917	96

Table 5. — Matrix of Transition Probabilities for Farm Operators 45 Years of Age or Older in 1948 or at Entry Into Farming

Tenure status in year t	Tenure status in year t+1					
	Exit pool	Joint-operator	Tenant-operator	Part-owner operator	Owner-operator	Total number of observations (operator-years)
Entry pool	.900	.067	.000	.000	.034	30
Joint-operator	.009	.902	.054	.027	.009	112
Tenant-operator	.031	.008	.901	.047	.012	255
Part-owner operator	.005	.016	.000	.789	.189	185
Owner-operator	.018	.018	.000	.000	.964	109

by 1960 even the oldest in this group would not have been over 58 years old. Table 5, on the other hand, shows a very low entry rate relative to the number leaving farming. This would be expected from a sample of operators 45 years old or older at the beginning of our period in 1948.[8] By 1960 even the youngest of those who were farming in 1948 would have been at least 58 years old.

The probabilities reported in Table 4 may be interpreted as follows. Out of a total assumed observation of 118 man-years among potential farm operators, 60.2 percent were accounted for by those who did *not* enter farming. Among the 39.8 percent accounted for by those who started farming in this period, 10.2 percent were spent as joint-operators, 28.8 percent as tenant operators, and 0.8 percent as part-owners. Of the 325 operator-years accounted for by those who were joint-operators in 1948, a total of 89.8 percent were spent by remaining in this category, 7.8 percent were spent as tenant-operators, 1.5 percent as part-owners, 0.6 percent as owner-operators, and one man quit farming. The other rows are interpreted similarly. The table as a whole reveals, among farm operators of this age, a pattern of rather remarkable tenure stability. For example, the probability that a man who is a part-owner this year will remain a part-owner next year is 0.944.

This general pattern of tenure stabil-

[8] The size of the entry pool for this age group was arbitrarily set to represent an entry rate of 10 percent from a pool of potential entrants. The rate of entry by those with nonfarm backgrounds is not quite this high.

Table 6. — Actual Tenure Distribution for 1948, 1950, 1955, and 1960 and Equilibrium Tenure Distribution for Operators Less Than 45 Years of Age in 1948 or at Entry Into Farming

Year	Joint-operator	Tenant-operator	Part-owner operator	Owner-operator
1948......	.192	.692	.081	.035
1950......	.174	.667	.110	.047
1955......	.145	.610	.198	.047
1960......	.076	.564	.267	.093
Equilibrium	.075	.522	.308	.095

ity also is characteristic among farm operators age 45 and older. However, if one sets both of these probability tables against a possible farm operator life-time of 40 years, the cumulative effect is one of profound change.

If the matrices represented by Tables 4 and 5 are regular, then the equilibrium or stationary tenure state may be estimated. This equilibrium tenure state distribution for the group under 45 years old is shown in Table 6. It should be noted that the equilibrium tenure distribution is not greatly different from the distribution that existed in 1960. Contrast this table with Table 7 in which the 1960 position was considerably different from equilibrium distribution. The direction of movement is very definitely toward owner-operatorship and toward joint-operatorships among these operators of 45 years or older, while among the younger operators it was toward part-owners, and away from joint-operators, plus a slight decline in a continuing high rate of tenancy. Table 8 reveals the contrasting equilibrium positions and must be interpreted with a good deal of caution due to our sample limitations. It is quite probable that the movement toward joint-operatorship among the 45 years and older group has been overstated and the movement toward owner-operators has been understated because we failed to get data on some of the older operators.

Table 7. — Actual Tenure Distribution for 1948, 1950, 1955, and 1960 and Equilibrium Tenure Distribution for Operators 45 Years Old or Older in 1948 or at Entry Into Farming

Year	Joint-operator	Tenant-operator	Part-owner operator	Owner-operator
1948......	.139	.389	.250	.222
1950......	.111	.444	.220	.224
1955......	.181	.294	.251	.274
1960......	.207	.293	.208	.294
Equilibrium	.242	.132	.060	.566

Table 8. — Equilibrium Distributions for Farmers Less Than 45 Years Old in 1948 or at Entry Into Farming and for Farmers 45 Years Old or Older in 1948 or at Entry Into Farming

	Joint-operator	Tenant-operator	Part-owner operator	Owner-operator
Less than 45........	.075	.522	.308	.095
45 and over......	.242	.132	.060	.566

The results amply demonstrate: (1) the potential value of the Markov chain as a descriptive device in tenure research, (2) the significance of joint-operators as a tenure class, and (3) the importance of age of operator as a variable in tenure analysis. Plans for further application of the Markov technique include: (1) a repeat tenure study employing a probability sample to eliminate the deficiencies in the present sample, and (2) an extension of the technique to measures of size of farm and volume of business.

Quality-Adjusted Price Indexes for Farm Tractors, 1950-1962

LYLE P. FETTIG

AS NEW TECHNOLOGIES ARE adopted in growing crops and livestock, increases in the use of nonfarm-produced capital items are necessary. It is primarily in this connection that the "cost-price squeeze" has arisen. These costs bear directly upon farm efficiency and size.[1]

In this report, another important aspect of this problem is examined, using new farm tractors as the capital input being studied. The basic question asked is: "If objective adjustments are made for changes in the 'quality' of farm tractors in the postwar period, what has happened to the real price of these tractors over this period?" Since there are qualitative differences, we need to look at quality as well as costs before we are able to make meaningful statements about price. The primary idea of adjusting for quality changes in new farm tractors has general applicability to all inputs and products. The specific techniques used for tractors and the findings in this application are summarized in this article.[2]

Background

As of January 1, 1961, there were an estimated 4.78 million tractors on farms in the United States. Ninety-eight percent of these were wheel type, the remainder track-laying type. Wheel tractors for domestic farm use shipped by manufacturers to dealers between 1950-1960 inclusive were equivalent *in number* to 65 percent of the wheel tractors on farms as of the 1961 date.[3]

Of course, *numbers* of tractors is not a very accurate measure of the stock of capital on farms in the form of tractors. Some are old, some are new, some are large, some are small. There are also differences in the composition and in the use and care of tractors. The problems of measuring such a heterogenous collection in comparable units are myriad.

This study attempts to take qualitative differences in new wheel tractors into account in the construction of a price index. The definition of this price index, besides being directly of interest, allows one to deflate expenditures on tractors to arrive at an estimate of the "quantity" of new tractors purchased in more comparable units of measurement. There is no conceptual difference between "quantity" and "quality" if one has the proper conversion ratios.

Changes in the Characteristics of Wheel Tractors[4]

General-purpose tractors for plowing, cultivation, and general all-around service adapted to attachable implements were widely accepted by the late 1930's. High-compression and diesel engines were introduced about 1935, and by 1940 rubber tires were included on 95 percent of the wheel tractors produced.

[1] Cf. J. C. Kohout and J. C. Headley, "The Relation of Cost and Farm Size on Western Illinois Livestock Farms," *Illinois Agricultural Economics*, July, 1962, pp. 16-22.

[2] For a more complete treatment and references, see the author's unpublished doctoral dissertation, "Price Indexes for New Farm Tractors in the Post-War Period," University of Chicago, 1963.

[3] The stock figure for 1961 is from *Agricultural Statistics, 1961,* U.S. Dept. Agr., 1962, p. 443. The flow for the period 1950-1960 is from *Current Industrial Reports,* "Farm Machinery and Equipment," Series M 35A, U.S. Bureau of Census, annual reports.

[4] For a historical compilation of these changes, see R. B. Gray, *Development of the Agricultural Tractor in the United States,* American Society of Agricultural Engineers, 1958.

Changes in wheel tractors, coming primarily from the advent of World War II to the present, include the following: (a) a variety of hitches, such as "one point," "two point," three point," "fast," etc.; (b) hydraulic systems, recently converted to "continuous" pump systems on many tractors; (c) remote-control hydraulics; (d) power take-offs, more recently refined to "independent" pto; (e) power steering; (f) power-adjusted rear wheels; (g) hydraulic transfer of weight; and (h) transmission changes in gear ratios, travel speeds, torque amplifiers, and automatic transmissions.

There were also improvements in safety and comfort, and a number of more subtle changes such as: better alloys and rotators in connection with engine valves; increased use of bearings; better spark plugs and lubricating systems; improvements in air, fuel, and oil-filtration systems; and gages and metering devices that improve the ability of the operator to perform maintenance.

The purchase of diesel tractors and tractors of higher horsepower capacities has also greatly increased.

Methods Used in Constructing Indexes

Considering the changes in wheel-tractor purchase costs from year to year, it is conceptually useful to distinguish among three components these changes represent: (1) changes in "basic" specifications, such as horsepower capacity or durability characteristics; (2) changes in attachments to the base unit, such as hydraulic systems and independent power take-offs; and (3) changes in the price *per se* of the base unit and its attachments. The desired price index is one that adjusts for the first two (quality) components in measuring the third.

Adjustment for changes in basic specifications. Cross-sectional regressions are computed for the various tractor models available in a given year. In these regressions (with each model as an observational unit) price of the model is taken as the dependent variable and specifications of the model (such as horsepower and weight) are used as independent variables. That is, price is taken as a function of the specification variables.

The regression coefficients are estimates of the price paid per unit of each of the various specifications, when the other included specifications are held constant. These coefficients can be used to adjust the price of an "average" model for the average changes in these specifications over time.

The basic justification for using this approach rests upon the validity of the assumption that *relative* prices among models (and hence, differences in prices between models) are a reflection of the relative quantities of the specifications embodied in the models. Specifications that are relevant over time are needed to make the approach valid.

Adjustment for changes in attachments. "Prices" of tractors, both for a given year (cross-section) and through time (time-series), vary in part because of differential levels of attachments, such as those listed above. As time has passed, more attachments have been included in the purchase cost of tractors as these are regularly equipped. This price variability was removed by "stripping" the tractor models and their prices of items over and above the base tractor. The base tractor was equipped only with starter and lights.

This adjustment procedure is not a precise or "clean" process in practice. When objectively applied, however, it should not result in a systematic bias in prices on the average. Nevertheless, caution is required in interpreting the residual for any given observation as evidence of "under" or "over" (relative to other models) pricing of the model in question.

Making the adjustment for attachments in this manner requires the associated assumption that the price of attachments has behaved in the same way as the price of the "stripped" tractor. Over the period of 1950 to 1962, the simple average of the ratio of tractor prices on an unadjusted basis to tractor prices on an adjusted (stripped) basis rose from 1.01 to 1.21. Thus in 1962 the adjustment of prices of tractors, *as regularly equipped,* amounted to 21 percent.

Selection of the sample. The tractors selected for the cross-sections were restricted to models of the eight leading manufacturers who have accounted for 85 to 90 percent of tractors shipped. Models of these manufacturers were restricted to those having both a current list price and a Nebraska tractor test. Models designed and equipped for industrial uses were excluded. "Duplicate" models, such as models in a given series having differences from included models only with respect to front-end design, high-clearance features, or special equipment for specific types of operations were excluded. Liquified-petroleum gas tractors and tractors with automatic transmissions were similarly excluded.

The number of models meeting these criteria ranged from 39 in 1950 to 65 in 1961. It would have been desirable to weight the various models, and hence manufacturers, according to sales, but such data were not available.

Variables Used in the Analysis

Price data. The prices used in this study were list prices of new tractors, f.o.b. factory, for the spring months, the seasonal sales peak for farm tractors. These list prices were used with the recognition of certain shortcomings. The major of these is the probability that the degree of "discounting from list" to arrive at actual transaction prices has changed over time. This may be done either by changing the discount in the case of no trade-in connected with the sale or by varying the trade-in allowance, amounting to the same thing. The list prices were checked for discounting by comparing them with prices collected by the USDA and with used-tractor prices. These comparisons did not give conclusive evidence of increased discounting. However, there is the additional problem of how adequately the USDA and used-tractor prices measure transaction prices.[5]

Specification data. The variables used in the explanation of cross-sectional prices of tractor models, adjusted for attachment-level differentials, in the end narrowed to two: belt horsepower and whether the tractor was equipped with a gasoline or diesel engine.

The other variables tried in the analysis were horsepower hours per gallon of fuel, maximum pounds of pull, miles per hour at maximum drawbar horsepower, weight of the tractor as tested, maximum drawbar horsepower, and a variable indicating whether the model was a standard wheel or row-crop type of tractor. The performance variables are from the Nebraska Tractor Tests and are corrected for differences in atmospheric conditions.[6]

The regression results prompted the decision to eliminate variables other than belt horsepower and engine type for either of two reasons: nonsignificance of the estimated coefficient for the variable, or a very high correlation with belt horsepower so that the variable contributed no additional explanation of price variance.[7] Although only two specification

[5] Cf. *Agricultural Prices and Parity,* Vol. I of *Major Statistical Series of the USDA,* Agriculture Handbook 118, 1957, p. 36.

[6] For a description of the development and nature of these tests, see L. W. Hurlbut, *et al.,* "The Nebraska Tractor Tests," *Agricultural Engineering* 41:229-231, 1960.

[7] Maximum pounds pull, drawbar horsepower, and weight as tested were highly correlated with belt horsepower. The other eliminated variables had nonsignificant coefficients.

Table 1. — Regression Results for Cross-Sections, 1950-1962

Year	Constant a	Coefficient of Horse-power X_1	Coefficient of Diesel X_2	R^2	Mean price	Standard error of estimate (percent)
1950	$176.02	$43.81 (2.06)	$826.77 (87.27)	.951	$1,871	8.98
1953	190.81	48.10 (2.17)	785.59 (77.04)	.954	2,158	8.39
1954	97.27	49.61 (2.51)	728.47 (83.79)	.945	2,132	9.47
1955	121.60	47.56 (2.63)	720.08 (91.92)	.936	2,290	10.45
1956	211.84	48.18 (2.25)	777.75 (79.89)	.957	2,515	8.47
1957	252.26	48.22 (2.51)	721.88 (83.56)	.932	2,669	9.55
1958	237.85	52.62 (3.14)	819.62 (93.41)	.912	2,911	10.24
1959	129.23	55.51 (3.39)	663.27 (100.78)	.901	2,908	11.11
1960	22.29	58.36 (2.51)	567.97 (81.93)	.936	3,129	8.79
1961	118.90	56.76 (2.90)	591.19 (100.41)	.883	3,421	11.40
1962	288.01	53.76 (2.93)	583.51 (102.64)	.876	3,415	11.30

variables remained in the regression analysis, more than these two were controlled over time. First of all, major attachments were adjusted for, and secondly, tractors with special features were not included in the cross-sections.

Regressions and Resulting Indexes

Cross-sectional regressions were computed for each of the years included in the study. The results from these regressions were then used to construct the tractor price index. In these regressions, tractor price in dollars was related to units of horsepower and a diesel "dummy" variable. This dummy variable took the value of 1 if the tractor model had a diesel engine and 0 if the tractor had a gasoline engine.

Regression results. Table 1 gives the results from the fitted equations. The two specification variables account for 88 to 96 percent of the variance in the adjusted prices of the tractor models. The coefficient of the horsepower variable shows an upward trend, indicating a rise in average price per horsepower, holding the diesel variable constant.

The price of having a diesel engine in place of a gasoline engine decreased from a level of about $800 to about $600 over the period. This reduction in the differential in the price between gasoline- and diesel-powered tractors has been recognized as one reason for the shift from gasoline to diesel tractors in recent years.[8] The standard error of estimate, expressed as a percentage of the average price for each cross-section, is also given in Table 1. The standard error for any given observation is roughly 10 percent for each of the regressions. The standard error of prediction for the average price is of course much lower than this.[9]

[8] *The Farm Cost Situation,* Econ. Res. Ser., U.S. Dept. Agr., May, 1962, p. 9.

[9] Because $S_{\text{sample}} = \frac{S_{\text{individual observations}}}{\sqrt{2(n-1)}}$ where n is the number of observations.

If we look at the 1962 regression as a specific example to understand the interpretation of these regressions, the results indicate that at the mean levels of the two variables, an additional horsepower costs $53.76 and the substitution of a diesel engine for a gasoline engine costs $583.51. The numbers in parentheses below the estimated coefficients are their respective standard errors. The other regressions have similar interpretations.

Resulting indexes. The results from the regressions given in Table 1 were used directly to estimate an index of the price of tractors held constant with respect to the level of the two quality dimensions, horsepower and engine type. Table 2 gives the resulting price indexes when a fixed set of horsepower and engine-type specifications was substituted into the regression equations. Solutions to this substitution were then put on a 1954-55 base.

The specifications for horsepower and diesel are based upon production information published in the "Current Industrial Reports" series given in Table 3. In these computations, liquified-petroleum gas tractors are added to diesel tractors for the diesel specification. The average horsepower is a weighted average obtained by weighting tractors in the various horsepower classes by production.

The choice of the base year for the specifications in the computation of an index is important, as indicated by comparison of the indexes based upon 1954 and 1960 specifications.

The "chained specifications" index of Table 2 comes closest to filling the criterion of index number construction that the index be representative of the "volume sellers" in the time period. In this index, the price relatives (i.e., P_t/P_{t-1}) are found for the given years, using the specifications of the previous year in each case. These price relatives are then used to construct the "linked" index. This index differs from the indexes based upon 1954 and 1960 specifications as a consequence of the trends in the horsepower and diesel dimensions (Table 3) and their coefficients (Table 1).

Table 2. — Wheel Tractor Price Indexes

	Constructed indexes			USDA composite index[b]
	Specifications			
	1954	1960	Chained[a]	
1950	95	96	94	93
1953	103	103	103	101
1954	101	101	101	99
1955	99	99	99	101
1956	104	104	105	106
1957	106	104	106	112
1958	114	113	114	117
1959	113	112	113	122
1960	113	112	113	123
1961	115	112	114	123
1962	117	113	114	127

[a] Specifications for 1950 and 1953 are at 1953 level. For all other pairs of adjacent years, specifications for the earlier year of the pair were used. Source of specifications is given in Table 3.
[b] Unpublished index from Farm Income Branch, ERS, USDA.

Comparison With USDA Index

The USDA constructs indexes for tractors by horsepower classes, and strives to obtain average prices for tractors as they are usually equipped. Thus,

Table 3. — Average Horsepower and Percentage of Production by Fuel Type, Wheel Tractors, 1953-1961

Year	Average maximum belt horsepower	Percentage of production using		
		Gasoline	Diesel	LP-gas
1953	35	93	6	1
1954	39	87	11	2
1955	40	84	13	3
1956	40	82	13	5
1957	42	78	16	6
1958	45	72	23	5
1959	47	65	30	5
1960	50	55	41	4
1961	51	49	47	4

Source: Data for 1953-59, Julius J. Csorba, "Farm Tractors: Trends in Type, Size, Age, and Use," U.S. Dept. Agr. Agriculture Information Bulletin 231, August 1960, Table 5, p. 6. Data for 1960-61, computed from *Current Industrial Reports,* Series M35S, U.S. Bureau of Census, annual issues.

for example, the fact that farmers purchase a higher proportion of diesel tractors results in a higher "price" index than if they had purchased proportionately more gasoline tractors. These (USDA) indexes are really "unit value" indexes by horsepower classes that do not allow for changes other than the movement from one horsepower *class* to another. Prices are reported to the various state crop reporting offices by dealers and averaged for the nation on a weighted average basis. These are offer prices and not actual transaction prices.

Table 2 also gives a comparison of the chained specification index with the composite index for all horsepower classes provided by the USDA. On a base of 1954-55, the constructed index rose to a level of 114 by 1962 compared with a rise of 127 for the USDA composite tractor index. Put differently, the USDA index in 1962 is 11 percent higher than the constructed index.

The amount the USDA index exceeds the constructed index is substantial, particularly since the constructed index is considered to be an upper limit of the actual price rise, taking quality changes in tractors into account. It is an upper limit for several reasons. First, the index is based upon list prices, and there is a reasonable presumption that actual transaction prices have not risen as much as list prices have over the period 1950 to 1962. Second, not all quality changes have been adjusted for because of lack of ability to make objective measurements. Finally, the assumption that the price of attachments has moved the same as the price of the base tractor, as implied by the "stripping" technique, may not be valid. It is mere speculation, but if the "productivity" of developments such as hydraulic systems could be measured, the "real" price of these attachments would probably be found to have decreased over time.

Implications

The methods used in this study allow some objective adjustment of tractor prices for "qualitative" changes. In order to use the cross-sectional technique, specifications must be measurable and there must be cross-sectional variance in the specifications. It is probable that there are some specifications that are important over time that do not exhibit much cross-sectional variance. This possibility was examined in the case of fuel economy.[10]

Performance data other than those in the Nebraska tests, such as durability characteristics and other operating efficiencies, are not available.

The definiteness of the results of this specific application would be increased if prices more adequately measuring transactions could be obtained and if information on market shares was available to weight the observations according to market importance in the regressions.

The results of this study give an indication of the practical as well as the conceptual importance of making a proper distinction between *cost* and *price*. The sole objective has been to measure tractor prices accurately and no attempt has been made to evaluate the price changes normatively.

Individual farmers still need to choose the power units that will allow them to maximize returns for their efforts, but should keep in mind what is being purchased in comparing the cost with that of the tractors purchased some years back. This statement can be generalized to include all inputs and outputs purchased by all members of our economy. It is in this latter context that the findings of this study are most interesting.

[10] It was found that while there was a steady and marked increase in fuel economy from 1920 to 1940, this indicator remained relatively stable over the period of this study. (Source: Nebraska Tractor Tests.)

Cash Rental of Livestock Facilities on Crop-Share Leased Farms[1]

R. P. SNODGRASS, W. N. THOMPSON, and F. J. REISS

TENANT-OPERATED FARMS comprise a considerable portion of both the total farms and the total acres in farm land in Illinois. There are numerous reasons why landlords own land and rent it to tenants, who in turn have their reasons for renting. One of the reasons common to both groups is, of course, to obtain income. The provisions for the attainment of this income are frequently set forth in a written lease between the landlord and the tenant.

The lease should permit and encourage efficient use of resources in the farm business. Resource efficiency on rented farms is achieved only when the combined resources of the landlord and tenant are organized into a farm plan that maximizes profits to their combined resources. A landlord leasing under a livestock-share lease, contrary to the situation under a crop-share lease, has an incentive to contribute at least a portion of the livestock buildings and equipment because he receives a direct return in the form of livestock earnings from such an investment. When landlords with crop-share leases prohibit the full utilization of available tenant labor or of roughages by not allowing the tenant to rent additional land, or by being unwilling to provide livestock buildings and other facilities, resource inefficiency exists.

Several methods exist whereby livestock facilities may be provided on crop-share leased farms and achieve greater efficiency of resource use. They may be provided by the tenant, and he in turn should secure either a written agreement with the landlord guaranteeing reimbursement of the unexhausted portion if he leaves or a permit allowing removal of such improvements that can be moved. Another alternative is that of the landlord providing the facilities and renting them to the tenant. This study indicates the need for livestock facilities in various farm situations and analyzes the different types of cash rental for these facilities.

Objectives

The objectives of this study were:

1. To determine the effects of the addition of a multiple-farrowing swine enterprise, a long-fed steer-calf program, and a short-fed yearling-cattle system on costs and returns to landlords and tenants for farms varying with respect to size, amount of available labor, and land quality.

2. To determine the constant annual rental payment required to return the landlord's original investments at varying interest rates within different time periods for various values of livestock capital improvements.

3. To determine the rate of interest that would be returned after varying lengths of time when different constant annual rental payments are made for various values of livestock capital improvements.

Procedure

Total farm budgets were used in this study to determine the effects of the addition of livestock on tenant and landlord returns to unpaid labor, land, and management. The types and amounts of livestock enterprises added were assumed to come reasonably close to maximizing

[1] This study is reported in more detail in Richard P. Snodgrass, "Cash Rental of Livestock Facilities on Crop-Share Leased Farms," unpublished Master's thesis, University of Illinois, 1963.

the total farm income from the given land and labor resources.

Certain buildings and other livestock facilities were assumed to be needed on the farm before the successful implementation of any livestock enterprises could occur. As an incentive condition necessary to encourage a farm plan that will maximize profits from the combined resources of the landlord and tenant, the share of a factor of variable input must be the same as the share of output obtained from it. The cost of livestock facilities prior to their erection by the landlord for purposes of rental to the tenant will be a variable input because the landlord may elect to incur or not incur the cost. Consequently, in order to encourage the establishment of these facilities so as to maximize total income from the combined resources, the tenant should pay the cost of the facilities and all associated expenses in his periodic rental payment.

Another incentive condition indicates that each resource owner must receive the full share of the product earned by each unit of resource he contributes. Determination of the full share of livestock earnings resulting from each unit of livestock facility contributed by the landlord and to be awarded him involves computation of the marginal value product of each unit.[2] Since such computations are extremely difficult, if not impossible, for the various livestock facilities, it was assumed that repayment of the initial cost and associated expenses over time as an annual cash rental approximated the fulfillment of this condition. The various types of cash rental were analyzed in terms of repayment of the principal plus interest over time. Estimates were made of the maintenance and repair costs, taxes, and insurance in computing the rental that will cover such associated expenses.

[2] Marginal value product is defined as the net increase in value of physical output resulting from the addition of one more unit of the variable resource.

Farm Earnings and Labor Utilization With and Without Livestock

Farm sizes of 160, 280, 360, and 520 acres were selected and studied primarily because of the efficiency of use of assumed labor resources. The 160- and 280-acre farms required less than one man during peak labor months, the 360-acre farm utilized approximately one man during peak labor months, and the 520-acre farm required more than one man but less than two men during peak labor months. It was assumed that the one-man labor supply provided a maximum of 240 hours in any one month and 2,880 hours per year, and two men provided twice as much labor in any one month and per year.

Each of the farm sizes was budgeted initially as a cash-grain operation under an intensive C-Sb-C-Sb-Sg (leg) rotation with no livestock. In addition, the 280-acre farm was also budgeted for a C-C-Sb-Sg-L rotation where such features as topography may require a stand-over hay and pasture crop to achieve an acceptable degree of erosion control. The intensive rotation was selected because crop-share and crop-share-cash leased farms are most prevalent in areas characterized by generally level, highly productive soils; this is indicated by the fact that 80 percent of the leases in the east-central Illinois area were such leases in 1959. Consequently, crop yields were selected that were based upon recent five-year averages (1957-1961) for the soil types in this area. The costs of crop production, labor requirements, and the distribution of direct labor used in this study were based on detailed cost studies of farms enrolled in the Illinois Farm Bureau Farm Management Service in the east-central Illinois area.

Table 1. — Returns to Unpaid Labor, Land, and Management and Labor Utilization With and Without Livestock, by Size of Farm[a]

Size of farm	Crop acres	Litters of hogs or head of cattle	Returns: Crops only	Returns: Crops and livestock	Labor utilization: Crops only	Labor utilization: Crops and livestock
			(dollars)		(hours)	
160 acres	150					
Tenant's share		92 litters	$2,439	$6,386	1,005	2,845
Landlord's share			2,745	2,745		
280 acres	260					
Tenant's share		80 head	4,285	6,178	1,225	2,732
Landlord's share			4,926	4,982		
280 acres	265					
Tenant's share		66 litters	5,226	8,145	1,561	2,881
Landlord's share			5,400	5,400		
360 acres	340					
Tenant's share		80 head	6,707	6,309	2,003	2,883
Landlord's share			6,929	6,978		
520 acres	490					
Tenant's share		116 litters	6,666[b]	11,802	2,886	5,206
Landlord's share			9,987	9,987		

[a] No rental charge has been deducted for the livestock facilities furnished by the landlord. Also, the value by which fertilizer costs would be reduced as a result of application of manure to cropland is included as an income item.
[b] Wages for a full-time hired man have been deducted.

To more fully utilize the tenant's excess labor on the intensively cropped farms, multiple-farrowing swine systems of sizes varying according to the amount of excess labor available were added to the 160-, 280-, and 520-acre operations. The intensively cropped, 360-acre farm had a short-fed yearling-cattle operation added. A long-fed steer-calf program was added to the 280-acre farm that had a year of standover hay and pasture in its rotation.[3] To implement the various livestock systems, different buildings and other facilities were assumed to be needed, and estimates of the costs of such facilities were made.

Farm costs and returns were shared by the tenant and landlord in general accordance with those leasing practices occurring on the majority of the crop-share-cash leased farms in east-central Illinois. All grain crops were shared equally, and some expenses were shared while others were not.

Before an analysis of cash rental rates for livestock facilities is made, the existence of such problems as incomplete utilization of available labor, inability to market roughages on the farm where grown, and low farm income must first be established. The existence of such problems, the effectiveness of certain livestock enterprises in alleviating the problems, and the simultaneous increase in total farm income are indicated in Table 1. Although the rental cost of the buildings needed for the successful implementation of the various livestock enterprises has not been subtracted from the returns presented there, the need for and relative profitability of providing the necessary buildings and facilities are indicated. For example, given the purchase and selling prices, other costs, and

[3] All prices used in the study and the costs and rates of swine production were taken from: Hinton, R. A., "Farm Management Manual," Department of Agricultural Economics, University of Illinois, September, 1962. Beef production costs and rates of production taken primarily from "Manual of Beef Cattle Management," College of Agriculture, Purdue University, ID 26, November, 1958.

Table 2. — Annual Cash Rental That Will Amortize the Investment and Earn at Various Rates the Compound Interest Equivalent to That Earned by $10,000 Compounded for Various Years of Rental Payments[a]

Years	Annual cash rental and indicated rate of interest							
	1%	2%	3%	4%	5%	6%	7%	8%
10	$1,055.82	$1,113.27	$1,172.31	$1,232.91	$1,295.05	$1,358.68	$1,423.78	$1,490.29
15	721.24	778.25	837.67	899.41	963.42	1,029.63	1,097.95	1,168.30
20	554.15	611.57	672.16	735.82	802.43	871.85	943.93	1,018.52
25	454.07	512.20	574.28	640.12	709.52	782.27	858.11	936.79
30	387.48	446.50	510.19	578.30	650.51	726.49	805.86	888.27
35	340.04	400.02	465.39	535.77	610.72	689.74	772.34	858.03
40	304.56	365.56	432.62	505.23	582.78	664.62	750.09	838.60

[a] A charge for associated expenses such as repairs and maintenance, taxes, and insurance, paid by the landlord, should be added to the rentals in this table in order for the rentals to be net rates of return.

rates of production used in this study, the 92-litter per year multiple-farrowing swine enterprise added $3,947 "gross tenant earnings"[4] when the necessary facilities were present. Furthermore, all available labor except 35 hours was employed when swine were added. On the other hand, the 80-head short-fed yearling-cattle program reduced gross tenant earnings by $398, and indicated that addition of buildings and facilities for such an enterprise would be inadvisable under the given conditions of production, even though all available labor were utilized.

Types of Cash Rental

All types of cash rental considered are constant payments which do not vary from year to year, and are analyzed as compounded costs, the rate of compounding being the desired rate of return on the investment. The rentals are viewed as amounts of money placed away each year at a given rate of compound interest. The rental amounts must be large enough so that their value after a given number of years will be equal to that of the initial investment also placed away at compound interest for the same number of years. The costs of maintenance and repairs, taxes, and insurance, if paid by the landlord, are additional expenses which should be added to the basic cash rental covering the initial investment and interest.

A cash rental based upon expected rate of return. Derivation of this type of rental requires that a specific rate of return on the investment over a given time period be determined prior to computation of the annual rental, since the rate and the period determine the rental. Derivation of this type of rental necessitates the use of annuity tables. Table 2 presents the amounts of cash rent paid each year for different periods of time that will earn varying rates of return for every $10,000 initial investment. However, to earn the rates of return given, these rentals must be placed away at the chosen rate of interest each year for the number of years remaining in the time period; their total value at the end of the period will equal that of the initial investment compounded at the same rate for the same time. The rental values in Table 2 may be multiplied by the percentage which another investment is of $10,000 to obtain the annual rental for that investment which will return a given rate of return after a definite time period. The rentals listed in Table 2 are the same as would be required to repay a direct reduction type of loan of $10,000 at the given interest rates within the

[4] Tenant returns to unpaid labor and management before the rental cost of buildings has been subtracted.

Table 3. — Percent of Compound Interest Earned After Various Periods of Time When Annual Rental Is a Percent of Initial Investment[a]

Years of payments	Rental expressed as a percent of investment							
	3	4	5	6	7	8	9	10
	(percent of compound interest)							
10								
15					0.62	2.37	4.01	5.56
20				1.80	3.44	4.96	6.39	7.76
25			1.80	3.40	4.86	6.24	7.54	8.78
30		1.22	2.84	4.30	5.66	6.93	8.14	9.31
35	0.27	2.00	3.50	4.86	6.13	7.33	8.48	9.59
40	0.92	2.52	3.93	5.21	6.42	7.57	8.68	9.76

[a] The rates of interest were not included for rentals amounting to either 1 or 2 percent of the investment because more than 40 years would be required to earn any interest. This table can also be interpreted as indicating the number of years required to amortize the principal at the interest returns shown for payments of the given magnitudes relative to the initial sum. Obviously if payments were to stop before they would aggregate to a sum equal to the initial investment, there could be no interest earned.

given time periods. In repaying such a loan, a portion of the annual payment is considered interest on the principal remaining at the beginning of the year, and the balance is a principal reduction, with the principal completely amortized at the end of the period.

A cash rental expressed as a percent of original cost. This type of rent may be stated as either a continuing rent with no specified number of payments or fixed repayment date, or it may be a rent terminating after a certain number of payments or at a given date. This type of rent is more common than the amortization type, although it is usually not determined with a specific rate of return as a goal. This statement is based on the fact that most rates of return after a given number of years are not positive integers, such as 1 or 2 percent, but consist of decimal fractions, such as 1.22 or 2.84 percent (Table 3). These rates of interest were determined by linear interpolation of an annuity table. This type of rental has the property that any rental value expressed as any one of the percentages of the original investment listed in Table 3 will always return the same rate of return over identical time periods. Greater lengths of time over which the annual rental is received are required before any interest is earned on the investment when the lower rentals are charged because repayment of the principal is spread over more years.[5]

A flat-rate cash rental. A third type of cash rental studied was the "flat rate" type, such as $300 per year. This type may also be specified as either a continuing or terminating rent. The flat-rate rental is similar to that type expressed as a percentage of the investment since neither is usually determined so as to earn a specific rate of return on the investment, and both are used more than the type derived to achieve a specific rate of return over a given time period. The task of computing the rate of return earned by a specific flat-rate rental after a period of time sufficient to repay the initial investment involves prior knowledge of the magnitude of investment. The need to base the rate of return on the original cost is unlike that in which the rental is a percentage of the cost where the rates of return are the same for any rental that is a given percentage of the investment. Consequently, any schedule of rates of interest earned on a specific investment by charging a

[5] The passage of a certain amount of time before any interest is earned is based upon the implied assumption that the return of principal is a first claim against the rental.

Table 4. — Percent of Compound Interest Earned on $5,700 After Various Periods of Time When the Annual Cash Rental Is a Flat Rate

Years of payments	Annual cash rent									
	$150	$200	$250	$300	$350	$400[a]	$450	$500	$550	$600
	(percent of compound interest)									
10.........										0.94
15.........						0.65	2.19	3.64	5.02	6.34
20.........				0.49	2.04	3.47	4.81	6.07	7.28	8.45
25.........			0.72	2.23	3.61	4.89	6.10	7.24	8.35	9.42
30.........		0.33	1.87	3.24	4.50	5.68	6.80	7.87	8.90	9.91
35.........		1.19	2.60	3.87	5.04	6.15	7.20	8.32	9.21	10.17
40.........	0.25	1.77	3.08	4.28	5.39	6.44	7.45	8.43	9.38	10.32

[a] Note that $400 is just slightly above 7 percent of $5700. Therefore, the rates of return in this column are nearly identical with the 7 percent column in Table 3.

given flat-rate rental over various periods of time is applicable to another identical rental rate only if that rental is for an investment costing the same as the former. Table 4 indicates the rate of return achieved after varying time periods for given flat-rate cash rentals on a $5,700 farrowing house needed for the livestock program on the 160-acre farm.

An illustration of rental based on expected rate of return. Since the type of cash rental based upon expected rate of return enables one to establish a cash rental that will earn a desired rate of return over a preselected time period, this type has been used to illustrate the profitability for landlord and tenant of erecting and renting livestock facilities (Table 5). Rental rates ranging from one that would repay the landlord's investment in as short a period as ten years at 8 percent interest to one that would repay the cost at 1 percent interest if received for 40 years were used as examples in Table 5. Rentals of such divergence also included maintenance and repair costs of 1 percent, taxes of 1 percent, and insurance of 0.5 percent of the new cost. Thus the livestock enterprises made possible through rental facilities added to the crop-share leased farms to achieve greater efficiency of labor utilization, market hay and pasture roughages that may otherwise be unusable, and increase tenant and landlord earnings were profitable over a wide range of cash rentals covering all costs of the facilities.

Once a decision is made to erect buildings and other facilities for the tenant's livestock under a crop-share lease, numerous other factors affect the determination of a cash rental. Selection of an appropriate time period over which

Table 5. — Returns to Tenant's Unpaid Labor and Management for Various Livestock Enterprises After Two Different Cash Rentals Are Deducted

Farm size (acres)	Litters of hogs or head of cattle added	Cost of facilities[a]	Rental rate A[b]		Rental rate B[c]	
			Rent	Returns	Rent	Returns
160..................	92 litters	$5,700	$ 991	$2,956	$316	$3,631
280..................	80 head	6,900	1,206	687	388	1,505
280..................	66 litters	5,455	951	1,968	304	2,615
520..................	116 litters	7,190	1,252	3,884	399	4,737

[a] The swine facilities consisted of a central farrowing house with no automatic manure disposal or feed processing and distribution unit. The cattle facilities included a 200-ton concrete stave silo, paved lot, and pole-type shelter barn.
[b] Rental rate A would return the landlord's investment in ten years at 8-percent interest.
[c] Rental rate B would return the landlord's investment in 40 years at 1-percent interest.

to fully recover all costs plus interest on the facilities should be conditioned by possible obsolescence due to advancing technology and the possibility of the tenant moving and the consequent difficulty of finding another willing to rent the existing facility. Decisions must be made regarding a further cash rental when there is a continuation of economic value in a structure beyond the time period over which the principal was repaid at interest.

Western European Import Propensities for Food, Beverages and Tobacco, and Oils and Fats

S. C. SCHMIDT

SOME OF THE CHANGE IN THE magnitude and geographical distribution pattern of Western Europe's composite food imports, as elaborated in the previous issue of this journal, was attributed to the diversity of the components of the composite category of food.[1] It is the primary objective of this paper to identify and explain the fluctuations of the components of Western Europe's composite food imports (food, beverages and tobacco, and oils and fats) and whenever feasible to estimate the comparative quantitative effects of import-affecting forces at work. The statistical technique chosen for obtaining such estimates was the single-equation least-squares analysis.

Food (SITC Section O) Imports From the United States

Consumption pattern.[2] Measured in terms of the proportions of total consumer expenditures devoted to various types of goods and services, food constitutes the largest single component of consumption in the countries of Western Europe (OEEC).[3] Out of a total expenditure of $145 billion in 1955, Western Europe's consumers allocated 36 percent to foods, 12 percent to clothing, 10 percent to liquor and tobacco combined, and 8 percent to durables.[4] Generally, the relative amounts spent for food are markedly higher in the four southern countries (50 percent), which occupy the lowest rung of the European income ladder, than in the northern countries (30 percent).[5] Disparity in consumption standards also reflects the level of income. In the diets of the southern countries, cereals are much in evidence and provide the highest proportion of calories. By contrast, the percentage of calories derived from starchy foods is lower and that from animal protein is higher in the more prosperous northern region. It must be remembered, however, that other factors such as relative prices, climate, occupa-

[1] S. C. Schmidt, Western European Food Import Propensities and Elasticities, *Illinois Agricultural Economics,* Vol. 3, No. 1, January, 1963.

[2] The Standard International Trade Classification (SITC) developed by the United Nations and put into effect in 1951 divides trade magnitude into ten commodity sections. Under this system of classification, food is identified by the code Section 0 and represents the sum of 36 different kinds of items. For a coverage of commodities included in Section 0 as well as those making up Section 1 and Section 4 see UN, Commodity Indexes for the Standard International Trade Classification, Statistical Papers, Series M., No. 10 (New York, 1953).

[3] Western Europe is defined as comprising all noncommunist countries of Europe (17) excluding Finland and Spain.

[4] Frederic J. Dewhurst, et al., *Europe's Needs and Resources,* Twentieth Century Fund, New York, 1961, p. 151.

[5] Ibid., p. 153. Relative expenditures for other categories of consumer's goods and services vary inversely with those devoted to foods.

tional structure, and eating habits also affect the pattern and standards of consumption and in turn imports.[6]

Agricultural self-sufficiency.[7] The greatest advances were achieved in bread grains and pork in which Western Europe already met the bulk of consumption from internal supplies (Supplement Table A1).[8] On the other hand, over-all dependence on imports has increased in coarse grains (feed), beef, and oils and fats.

Undoubtedly the growth of intra-OEEC output enhanced the scope of import substitution to the detriment of extra-regional suppliers (Supplement Tables A1 and A3). By far the greater part of OEEC's needs in bread grains, live animals, fruits, and vegetables is met from within the region (Supplement Tables A2 and A3).

In addition to the effects of progress in consumption standards and in the degree of intra-regional self-sufficiency, the growth of imports has been restrained by bilateral trade arrangements with the associated overseas areas manifested by freedom from quantitative restrictions or preferential tariff treatment.[9] Furthermore, it must be recognized that there were many special factors, some of a clearly nonrecurring sort such as weather and events accompanying the Korean and Suez emergencies, which affected the import picture.

Statistical results. In the interest of comparability, the independent variables, on the whole, were identical with those applied in analyses pertaining to composite food imports.[10] In terms of sign and statistical reliability, the estimating relationships and coefficients presented in Table 1 do not differ greatly from those for composite food imports.[11] This is not unexpected because food proper (SITC Section 0) dominated the import magnitude so completely that movements in beverages and tobacco (SITC Section 1) as well as in oils and fats (SITC Section 4) found little room for expression. In 1960, for example, two-thirds of composite food (SITC Sections $0 + 1 + 4$) imports from the United States consisted of food (SITC Section 0), while beverages and tobacco (SITC Section 1) and fats and oils (SITC Section 4) represented approximately one-fifth and one-tenth of the aggregate. And yet it should not go unnoticed that disaggregation, except for the ratio of U. S. to Canadian wholesale prices of farm products (X_{62}, equation 3, Table 1) results in a markedly lower degree of simple correlation between the dependent (X_{101}) and independent variables, such as X_2, X_{40}, and X_{51}, respectively. As a corollary, intercorrelation became more pronounced in the analyses of the separate categories than in the composite food analyses.

[6] OEEC, *The Consumer's Food Buying Habits,* Paris, 1958.

[7] A broad indication of changes in the degree of self-sufficiency may be gained from the rows identified "Production as percent of availabilities" in Supplement Table A1. All such supplement tables are presented in "Western European Import Propensities for Food, Beverages and Tobacco, and Oils and Fats, Statistical Supplement," Univ. Ill. Agr. Exp. Sta. Research Report AERR-60, available from the author.

[8] For a detailed discussion of various governmental policies aiming at self-sufficiency, see FAO, Report of the Expert Panel on Agricultural Price Stabilization and Support Policies, Rome, April, 1959; and FAO, National Grain Policies, Rome, 1959 (and supplements 1 and 2, 1959 and 1960).

[9] PEP, Commonwealth Preference in the United Kingdom, London, 1960; and UN, The Impact of Western European Integration on African Trade and Development, United Nations document E/CN 14/72, December, 1960.

[10] Composite food imports were defined as the sum of three commodity categories: foods (SITC Section 0), beverages and tobacco (SITC Section 1), and oils and fats (SITC Section 4). See S. C. Schmidt, Western European Food Import Propensities and Elasticities, *Illinois Agricultural Economics,* Vol. 3, No. 1, January, 1963, p. 26.

[11] Ibid., Table 1, p. 28.

In general, higher elasticity coefficients in terms of absolute value were obtained from analyses based on the disaggregated food import series (Table 2) than in the analysis of the composite series. This is especially apparent with respect to national income (X_2) and food import prices (X_{40}), both of which suggest a pronounced inverse association with changes in the pattern of food im-

Table 1. — Foods, Beverages and Tobacco, Oils and Fats: Factors That Affect Changes in OEEC Imports From the United States, 1951-1960

Equation number	Type of data[a]	Regression equations[b]	Coefficient of multiple correlation	Standard error of estimate
		Food (SITC Section 0)		
1	a	$X_{101} = 3{,}903.80 - 2.90X_2 - 24.97X_{40}$ (2.55) (14.55)	0.56	156.25
	b	$X_{101} = 4{,}287.72 - 2.91X_2 - 28.81X_{40}$ (3.85) (14.66)	0.69	159.65
2	a	$X_{101} = 2{,}702.01 - 17.65X_{40} - 0.07X_{51}$ (17.89) (0.16)	0.46	167.96
	b	$X_{101} = 3{,}275.80 - 23.83X_{40} - 0.04X_{51}$ (16.58) (0.15)	0.66	165.60
3	a	$X_{101} = 5{,}729.73 + 6.34X_{40} - 56.60X_{62}$ (10.95) (27.83)	0.70	134.80
	b	$X_{101} = 6{,}652.79 - 1.82X_{40} - 57.57X_{62}$ (10.42) (26.49)	0.81	128.30
		Beverages and Tobacco (SITC Section 1)		
4	a	$X_{102} = 80.27 + 0.58X_2 + 0.33X_{125}$ (0.32) (1.29)	0.60	30.56
	b	$X_{102} = 0.90 + 1.42X_2^c - 0.55X_{125}$ (0.47) (1.26)	0.83	29.62
5	a	$X_{102} = 6.55 - 0.02X_{51} + 2.53X_{75}$ (0.03) (2.00)	0.64	29.42
	b	$X_{102} = -56.06 + 0.01X_{51} + 2.70X_{75}$ (0.03) (2.03)	0.81	31.03
		Oils and Fats (SITC Section 4)		
6	a	$X_{103} = -419.91 + 1.01X_2^c + 3.07X_{40}$ (0.35) (2.01)	0.78	21.55
	b	$X_{103} = -375.46 + 1.49X_2^c + 1.68X_{40}$ (0.55) (2.09)	0.82	22.81
7	a	$X_{103} = -47.21 + 0.59X_2 + 0.22X_{126}$ (0.29) (1.33)	0.69	24 84
	b	$X_{103} = -148.67 + 1.15X_2^c + 0.12X_{126}$ (0.39) (1.21)	0.80	23.82
8	a	$X_{103} = -137.54 + 0.74X_2^c + 0.75X_{139}$ (0.24) (0.61)	0.76	22.57
	b	$X_{103} = -252.13 + 1.35X_2^c + 0.68X_{139}$ (0.34) (0.57)	0.84	21.74

[a] Where: *a* refers to functions based on current value data and *b* to functions based on constant (1953) dollar data. All trade series, import or export, pertain to millions in U. S. dollars. Variables have the following definitions: X_2 = national income (GNP at market prices), billions of U. S. dollars; X_{29} = ratio of OEEC export prices to OEEC food import prices; X_{40} = index of OEEC food import prices (1953 = 100); X_{51} = total exports (SITC Section 0-9) to the U. S. in millions of U. S. dollars; X_{62} = ratio of U. S. to Canadian wholesale prices of farm commodities (1953 = 100); X_{75} = index of production in food, beverages and tobacco manufacturing industries (1953 = 100); X_{101} = food (SITC Section 0) imports from U. S. in millions of U. S. dollars; X_{102} = beverages and tobacco (SITC Section 1) imports from the U. S. in millions of U. S. dollars; X_{103} = oils and fats (SITC Section 4) imports from the U. S. in millions of U. S. dollars; X_{125} = world average unit value indices of exports of beverages and tobacco (1952-53 = 100); X_{126} = world average unit value indices of exports of edible oils and oilseeds 1952-53 = 100); X_{139} = index numbers of international market prices of all fats and oils (1952-54 = 100).

[b] Numbers in parentheses beneath the regression coefficients are their respective standard errors.

[c] Coefficient differs significantly from zero at the 5-percent probability level.

Table 2. — OEEC Food (SITC Section 0) Imports From the United States: Estimates of Import-Expenditure Elasticities With Respect to Selected Economic Variables, 1951-1960

Type of data[a]	Effect on OEEC imports of a 1-percent change in[b]			
	X_2	X_{29}	X_{40}	X_{51}
a.	−1.02[e]	3.09[c,g]	−3.72[e]	−0.49[f]
	(0.71)	(1.21)	(1.72)	(0.64)
	−0.70[g]	([d])	−3.37[f]	([d])
	(0.52)		(2.50)	
b.	−1.37[e]	3.55[c,g]	−4.57[c,e]	−0.55[f]
	(1.07)	(1.22)	(1.78)	(0.57)
	−0.65[g]	([d])	−4.59[f]	([d])
	(0.77)		(2.25)	

[a] Where: *a* refers to coefficients obtained from analyses based on current value data expressed in logarithms and *b* refers to coefficients obtained from analyses based on logarithms of data in constant (1953) dollars. For definitions of variables, see Table 1, footnote a.
[b] Numbers in parentheses beneath the coefficients are their respective standard errors.
[c] Coefficient differs significantly from zero at the 5-percent probability level.
[d] No alternative estimate available.
[e] Based on coefficients obtained from the logarithmic equivalents of equation 1, Table 1.
[f] Based on coefficients obtained from the logarithmic equivalents of equation 2, Table 1.
[g] Based on equations:

$$\text{Log } X_{101} = 0.14 - \underset{(0.52)}{0.70} \log X_2 + \underset{(1.21)}{3.09} \log X_{29} \quad R = 0.71$$

$$\text{Log } X_{101} = 0.20 - \underset{(0.77)}{0.65} \log X_2 + \underset{(1.22)}{3.55} \log X_{29} \quad R = 0.78$$

ports from the United States.[12] However, the relevancy of the high coefficients for these factors must be questioned because except for X_{40} in one case neither is statistically significant.

The nature of these developments can only be seen in its proper perspective after some consideration is given to trends in the pattern of consumption standards (Supplement Table A5) and in the degree of self-sufficiency (Supplement Table A1) on one hand and in changes in the level and commodity structure of food imports obtained from the United States on the other (Supplement Table A4).

Chief products obtained from the United States were bread and feed grains, fruits, and miscellaneous feeding stuffs. Among these the relative significance of wheat in relation to other food items imported from the United States has fallen from 51 percent in 1951 to 28 percent in 1961; that of margarine from 6 to 4 percent. On balance, only feed grains, especially corn, fresh meat, and fruits gained in importance (Supplement Table A4).

It is also interesting to observe that no measurable benefits accrued to food imports from compensatory exports to the United States. The analyses yielded negative coefficients, ranging from 0.49 to 0.55, for the export variable (X_{51}) but because of the size of their standard errors they are not statistically significant (Table 2). Here again, interpretation is difficult. The inference is strong that in allocating their gold and dollar earnings OEEC countries attached higher priority to manufactures and industrial raw materials than to foodstuffs of American origin.[13]

In addition to the three independent variables discussed above, a fourth variable, terms of trade (X_{29}), referring to the ratio of OEEC export prices to OEEC food import prices, was introduced to ascertain the extent to which changes in the international price structure facing OEEC countries affect their food import decisions. Although there is evidence of a statistically significant positive association between changes in terms of trade conditions and pattern of food imports from the United States, the reliability of elasticity coefficients must be questioned on grounds that they ascribe an unrealistically large weight to price movements. Undoubtedly the influence of a gradual decline in food import prices had much to do with the sign and magnitude of elasticity coefficients that were obtained.

[12] It should be recognized, however, that because OEEC price indexes of imported foodstuffs are based on a much broader range of commodities than those obtained from the United States, they may not provide a reliable indication of the degree of price responsiveness.

[13] See OEEC, Statistical Bulletins, *Foreign Trade* Series IV and B.

Beverages and Tobacco (SITC Section 1) Imports From the United States

Beverages and tobacco represent a more important item of private consumption in member countries of OEEC than in the United States. In 1955, for instance, Europe's consumers devoted more than 10 percent of their total expenditures to beverages (6.2 percent) and tobacco (4.1 percent) in contrast with less than 6 percent allocated by U. S. consumers.[14]

There are several preponderant influences on consumption, and as a corollary, on imports of tobacco from the United States (since imports of SITC Section 1 commodities from the United States are almost entirely tobacco, beverages are not considered here):

1. The level of prices and incomes.
2. Degree of self-sufficiency. Production and exports of oriental leaf tobacco are of vital importance to the economies of Greece and Turkey, contributing 30 to 40 percent to total exports. France and Italy produce a substantial part of their requirements although only Italy is a net exporter of tobaccos.
3. Governmental control over the purchase and manufacture of tobaccos (state monopolies).
4. Rate of taxation (customs tariffs, fiscal levies, or both) imposed on these products. In 1955-56, taxes comprised 76 percent of the retail cost of tobacco in the United Kingdom, 54 percent in Austria, and 52 percent in Germany.
5. Preferential treatment extended to associated overseas producers (Algeria and other countries of the French community, as well as the British Commonwealth system of trading).
6. Consumer tastes such as manifested in the traditional attachment to oriental tobaccos in Germany and to Virginian types in the United Kingdom.

[14] Frederic J. Dewhurst, et al., op. cit., p. 151 and 193.

Statistical results. Since it is impossible to isolate and quantify the net and often conflicting impact of these various factors on the pattern of imports, the scope of analysis is necessarily limited and built around a few economic indicators readily amenable to statistical manipulation. To this end two sets of relationships involving four explanatory variables were formulated (Table 1).

In equation 4, world export prices of beverages and tobacco (X_{125}) were introduced as a separate variable in addition to national income (X_2). While the signs of each of the regression coefficients in equation 4b were in line with expectation, only the coefficient for national income was statistically significant.[15] This reflects both the shifts in consumer preferences accompanying the rise in national income experienced during the 1950's and the unavailability of intra-regional supplies. The influence of changes in export prices in the total fluctuations in beverages and tobacco imports appears to have been rather minor. It is to be borne in mind, however, that since imports of goods in this category from the United States consist to an overwhelming extent of unmanufactured tobaccos (Supplement Table A6), the composite price series has less relevance in measuring price responsiveness than in relation to import magnitudes with more balanced commodity structures. In 1961, for instance, alcoholic beverages accounted for 46 percent and unmanufactured tobaccos for 49 percent in Western Europe's over-all (world) imports of this combined commodity group (Supplement Table A6).

Attempts to improve explanation of the fluctuations in imports by introducing an alternative set of variables, notably total exports (X_{51}) and indices of pro-

[15] The degree of intercorrelation between the two explanatory variables was comparatively modest ($r = -0.54$).

Table 3. — OEEC Beverages and Tobacco (SITC Section 1) Imports From the United States: Estimates of Import-Expenditure Elasticities With Respect to Selected Economic Variables, 1951-1960

Type of data[a]	Effect on OEEC imports of a 1-percent change in[b]			
	X_2	X_{51}	X_{75}	X_{125}
a......	0.56[d] (0.35)	0.47[e] (0.26)	1.17[f] (1.21)	0.15[d] (0.64)
b......	1.26[c,d] (0.48)	0.61[c,e] (0.24)	0.80[f] (1.20)	−0.14[d] (0.61)

[a] Where: *a* refers to coefficients obtained from analyses based on current value data expressed in logarithms and *b* refers to coefficients obtained from analyses based on logarithms of data in constant (1953) dollars. For definitions of variables, see Table 1, footnote a.
[b] Numbers in parentheses beneath the coefficients are their respective standard errors.
[c] Coefficient differs significantly from zero at the 5-percent probability level.
[d] Based on coefficients obtained from the logarithmic equivalents of equation 4, Table 1.
[e] Based on equations:

$$\text{Log } X_{102} = 0.03 + \underset{(0.26)}{0.47} \log X_{51} + \underset{(0.77)}{0.63} \log X_{125} \quad R = 0.58$$

$$\text{Log } X_{102} = 0.004 + \underset{(0.24)}{0.61} \log X_{51} + \underset{(0.73)}{0.26} \log X_{125} \quad R = 0.77$$

[f] Based on coefficients obtained from the logarithmic equivalents of equation 5, Table 1.

duction in food, beverage, and tobacco-manufacturing industries (X_{75}), were not successful (equation 5). Although their order of association with the dependent variable approximates that of national income (0.76 and 0.77) owing to high degree of intercorrelation (0.94) neither of the individual regression coefficients was statistically significant.

Apart from the imperfections arising from a high degree of multicollinearity among the explanatory variables, the analyses assigned influences in a way that gave plausible elasticity coefficients for both national income and total exports to the United States (Table 3). Inspection of the coefficients presented in Table 3 indicates, for instance, that deflation raised the elasticity values for national income from 0.56 to 1.26 and those for total exports from 0.47 to 0.61, respectively.[16] This is no cause of surprise considering that while import prices followed a generally downward course both national income and total exports sharply increased. The analyses yielded no statistical evidence of any world export price (X_{125}) effect, which in a sense supplements the conclusions reached in other studies, notably that the domestic price elasticity of demand is very low.

Oils and Fats (SITC Section 4) Imports From the United States

Partly because of the limits imposed by climatic conditions on the production of oilseeds, the over-all degree of self-sufficiency in oils and fats combined has not substantially changed, and currently Western Europe as a whole still provides only about 50 percent of requirements (Supplement Table A1). Here again it must be recognized that the degree of self-sufficiency varies between countries as well as in regard to commodity categories.

In addition to disparity in rates of growth of domestic demand and supply conditions, movements in fats and oils imports were further affected by (1) the scope of governmental protectionist policies, (2) the nature of economic and institutional affinity between net importing and exporting countries, (3) changes in relative prices of easily substitutable food and nonfood products,[17] (4) U. S. shipments of soybean and cottonseed oils under special export programs such as PL 480, to countries in the Mediterranean area,[18] and (5) fluctuations in available supplies in international markets.

Statistical results. In view of the

[16] According to various consumer surveys conducted during recent years in Western Europe, the income elasticity of expenditure for tobacco approximates unity in the poorest countries (Greece, Portugal, and Spain), 0.8 in the middle-income countries (Finland, Ireland, and Italy) and 0.6 in all other countries. See Frederic J. Dewhurst, et al., op. cit., p. 211.

[17] FAO, Monthly Bulletin of Agricultural Economics and Statistics, Vol. 11, April, 1962; and USDA, ERS, Fats and Oils Situation, FOS-209, August, 1961, p. 27-32.

[18] U. S. Congress, House, Semi-Annual Reports on Activities Carried on Under Public Law 480, Washington.

statistical difficulties of allowing for factors such as governmental interferences in the production, consumption, and trade of oils and fats as well as technological factors which influence the utilization of various types of oils and fats, their affect on imports had been ignored. Apart from such imperfections a satisfactory, although not very precise, explanation in import pattern was obtained by application of standard explanatory variables, national income (X_2) and three alternative price series, food import prices (X_{40}), world export prices of edible oils and oilseeds (X_{126}), and international market prices of all oils and fats (X_{139}).

As indicated by the relationships expressed in equations 6, 7, and 8 as well as their coefficients, variations in imports appear to be most closely associated with changes in national income (Table 1). While the net regression coefficient between the import variable and national income in each equation is significant at the 5-percent probability level, because of positive signs and the size of their standard errors, little confidence can be placed in either import-price coefficient. The values of the simple correlation coefficients for variables X_{40}, X_{126}, and X_{139} in equations 6b, 7b, and 8b are −0.57, −0.46, and −0.23; that for X_2 is 0.80. Intercorrelations between the explanatory variables are −0.83, −0.59, and −0.54, respectively. Presumably differences in commodity structures among various import sources on the one hand and the aggregative nature of price variables on the other preclude an assessment of the implications of relative price movements on the magnitude of imports.

By and large, the income elasticity figures presented in Table 4 appear rather improbably high and may be attributable to the quality of the import statistics. Such inference may be supported by recent trends in the pattern of consumption levels in oils and fats in Western European countries. As shown in Supplement Table A5, apart from the Southern European region with the lowest standards of consumption, the intake of oils and fats remained either stationary or increased only moderately over

Table 4. — OEEC Oils and Fats (SITC Section 4) Imports From the United States: Estimates of Import-Expenditure Elasticities With Respect to Selected Economic Variables, 1951-60

Type of data[a]	Effects on OEEC imports of a 1-percent change in[b]				
	X_2	X_{29}	X_{40}	X_{126}	X_{139}
a	2.19[c,d]	0.84[e]	2.69[d]	−1.28[e]	1.26[g]
	(0.77)	(1.53)	(1.89)	(1.39)	(0.69)
	1.46[f]	....	....	0.59[f]	−0.30[h]
	(0.67)	....	....	(1.42)	(0.85)
b	3.33[c,d]	1.71[e]	1.91[d]	−1.37[e]	1.07[g]
	(1.09)	(1.55)	(1.83)	(1.41)	(0.60)
	2.54[f]	....	....	0.38[f]	−0.54[h]
	(0.82)	....	....	(1.19)	(0.93)

[a] Where: *a* refers to coefficients obtained from analyses based on current value data expressed in logarithms and *b* refers to coefficients obtained from analyses based on logarithms of data in constant (1953) dollars. For definitions of variables, see Table 1, footnote a.

[b] Numbers in parentheses beneath the coefficients are their respective standard errors.

[c] Coefficient differs significantly from zero at the 5-percent probability level.

[d] Based on coefficients obtained from the logarithmic equivalents of equation 6, Table 1.

[e] Based on equation:

$$\underset{}{\text{Log } X_{103}} = -0.14 + \underset{(1.53)}{0.84} \log X_{29} - \underset{(1.39)}{1.28} \log X_{126} \quad R = 0.44$$

$$\text{Log } X_{103} = -0.07 + \underset{(1.55)}{1.71} \log X_{29} - \underset{(1.41)}{1.37} \log X_{126} \quad R = 0.57$$

[f] Based on coefficients obtained from the logarithmic equivalent of equation 7, Table 1.

[g] Based on coefficients obtained from the logarithmic equivalents of equation 8, Table 1.

[h] Gross elasticity coefficient.

the 1953/54-1955/56 levels in other European countries.

Regional Import Expenditure Elasticities

It should be reiterated that because of dissimilar commodity structures, the sign and size of elasticity coefficients presented in Tables 5, 6, and 7 afford only a crude degree of comparability and their interpretation is subject to the qualifications previously discussed.

Food (Table 5). The following observations can be made: (1) While there are some exceptions such as Eastern Europe and Central America, the volume in contrast to the value of food imports tends to rise commensurate with or at a higher rate than national income (X_2).

Table 5. — Food (SITC Section 0): Estimates of Import-Expenditure Elasticities With Respect to Selected Economic Variables, 1951-1960

Area of origin	Type of data[a]	Effect on OEEC imports of a 1-percent change in[b]		
		X_2	X_{40}	Exports[e]
World	a	0.54[c] (0.09)	−0.14 (0.23)	[f]
	b	1.26[c] (0.11)	0.14 (0.19)	[f]
Intra-OEEC	a	0.77[c] (0.17)	−0.30 (0.41)	[f]
	b	1.58[c] (0.15)	−0.01 (0.26)	[f]
OEEC excluding EEC and European Sterling Area	a	0.54 (0.24)	−0.76 (0.58)	[f]
	b	0.91[d] (0.31)	−1.59[d] (0.52)	[f]
Central America	a	−0.33 (0.70)	−1.75 (1.52)	0.71[d] (0.23)
	b	−0.64 (1.07)	−2.61 (1.37)	0.81[d] (0.32)
South America	a	1.37[c] (0.17)	−0.68 (0.86)	0.56 (0.49)
	b	1.98[c] (0.31)	−1.36 (0.80)	0.66 (0.45)
Asia	a	1.16[c] (0.27)	0.60 (0.74)	0.61[d] (0.24)
	b	2.10[c] (0.45)	0.50 (0.81)	0.73[d] (0.26)
Oceania	a	0.46 (0.29)	−0.64 (0.45)	−0.24 (0.28)
	b	1.13 (0.54)	−0.99 (0.63)	−0.09 (0.38)
Eastern Europe	a	−0.84 (0.62)	−4.05[d] (1.50)	−0.17 (0.36)
	b	−1.01 (0.98)	−4.86[d] (1.64)	−0.16 (0.35)
European Sterling Area	a	0.71[d] (0.29)	0.94 (0.70)	−0.25 (0.35)
	b	0.82 (0.49)	−0.36 (0.82)	−0.08 (0.39)

[a] Where *a* refers to coefficients obtained from analyses based on current value data expressed in logarithms and *b* refers to coefficients obtained from analyses based on logarithms of data in constant (1953) dollars. For a definition of variables, see Table 1, footnote a. For a list of countries included in each area, see Supplement Table A12 in AERR-60.
[b] Numbers in parentheses beneath the regression coefficients are their respective standard errors.
[c] Coefficient differs significantly from zero at the 1-percent probability level.
[d] Coefficient differs significantly from zero at the 5-percent probability level. Coefficients without superscript do not differ significantly from zero at the 5-percent probability level.
[e] OEEC total exports to specified regional import sources.
[f] Not computed.

Among food import sources under consideration, the income elasticities are highest for Asia and South America, approximating 2.0, whereas those in other regions range from 0.82 to 1.58. However, these estimates have to be interpreted with a great deal of caution because of regional differences in commodity composition. It may seem reasonable to assume that imports from Asia and South America contain a heavier concentration of noncompeting commodities than those obtained from other regions. (2) Evidence as to the importance of OEEC exports as a food import-stimulating factor appears somewhat uncertain. Only imports obtained from Asia and Central America showed a statistically acceptable positive (although less than unity) response to changes in this factor. (3) Despite considerable variations in the magnitude of elasticity coefficients, it is possible to infer that food imports are responsive to price

Table 6. — Beverages and Tobacco (SITC Section 1): Estimates of Import-Expenditure Elasticities With Respect to Selected Economic Variables, 1951-1960

Area of origin	Type of data[a]	Effect on OEEC imports of a 1-percent change in[b]			
		X_2	X_{75}	X_{125}	Exports[e]
World	a	0.90[c] (0.11)	1.25[c] (0.24)	0.11 (0.20)	([f])
	b	2.03[c] (0.33)	1.92[c] (0.43)	0.26 (0.42)	([f])
Intra-OEEC	a	1.25[c] (0.09)	1.65[c] (0.20)	−0.07 (0.08)	([f])
	b	2.23[c] (0.17)	2.11[c] (0.20)	0.22 (0.21)	([f])
OEEC excluding EEC and European Sterling Area	a	1.36[c] (0.17)	([f])	0.58 (0.31)	([f])
	b	2.30[c] (0.35)	([f])	0.23 (0.44)	([f])
Central America	a	1.61[c] (0.16)	2.27[c] (0.27)	0.58 (0.35)	0.55[c] (0.14)
	b	2.37[c] (0.47)	2.34[c] (0.41)	0.07 (0.52)	0.52[c] (0.13)
South America	a	0.68[c] (0.17)	1.00[c] (0.23)	0.62 (0.31)	0.69 (0.34)
	b	1.26[c] (0.28)	1.26[c] (0.24)	0.69 (0.36)	0.79 (0.39)
Asia	a	0.41 (0.20)	0.65 (0.54)	−0.43 (0.38)	0.26 (0.16)
	b	0.97[d] (0.29)	0.98 (0.55)	−0.43 (0.41)	0.41[d] (0.17)
Eastern Europe	a	2.75[c] (0.61)	4.10[c] (0.77)	−1.13 (1.12)	1.60[c] (0.33)
	b	4.45[c] (0.85)	4.35[c] (0.77)	−1.09 (1.07)	1.64[c] (0.31)
European Sterling Area	a	0.54[c] (0.14)	0.75[c] (0.21)	−0.81[d] (0.26)	0.72 (0.40)
	b	1.10[c] (0.21)	1.05[c] (0.21)	−1.25[c] (0.27)	0.85 (0.42)

[a] Where *a* refers to coefficients obtained from analyses based on current value data expressed in logarithms and *b* refers to coefficients obtained from analyses based on logarithms of data in constant (1953) dollars. For a definition of variables see Table 1, footnote a, and for country coverage of areas of origin, see Supplement Table A12.

[b] Numbers in parentheses below regression coefficients are their respective standard errors.

[c] Coefficient differs significantly from zero at the 1-percent probability level.

[d] Coefficient differs significantly from zero at the 5-percent probability level. Coefficients without superscript do not differ significantly from zero at the 5-percent probability level.

[e] OEEC total exports to specified regional import sources.

[f] Not computed.

levels (X_{40}). Notably disregarding the fact that most of the coefficients are not statistically significant, there is a fair degree of uniformity suggesting that imports are affected by prices.

Beverages and tobacco. The general picture emerging from a review of coefficients presented in Table 6 is that: (1) The import expenditure elasticities with respect to national income (X_2) are generally higher (in terms of absolute values) for beverages and tobacco than those pertaining to either food or oils and fats. Although their values, especially those derived from deflated data, seem to be quite high, ranging from 0.97 for Asia to 4.45 for Eastern Europe, on balance they tend to reflect the combined effects of disparities in rates of growth between domestic production and consumption and a probable shift in consumer preferences from the lower to the higher priced products.[19] (2) Coefficients obtained for production in food, beverage, and tobacco-manufacturing industries (X_{75}) essentially confirm the inferences suggested by changes in national income. This is logical because of the causal interaction that exists between the course described by these two variables. (3) Imports, apart from those originating in the European Sterling Area, appear insensitive to changes in world export prices (X_{125}).

That changes in prices, whether internal or external, are subordinate to other considerations may gain support from the fact that over-all consumption of these products has continued to rise in spite of heavy increases in revenue taxes levied during the period under review. (4) There is some, though by no means conclusive, evidence that imports respond in a positive manner to changes in the flow of Western European exports.

[19] It should not escape attention that differences in the magnitude of import flows emanating from various regions may also lead to wrong impressions as to the degree of responsiveness. Thus, the estimates obtained for Asia and Central and South America, for example, owing to the comparative smallness of imports involved, are susceptible to containing an upward bias.

Oils and fats. The results presented in Table 7 suggest that excepting estimates obtained for over-all (world) imports none of the regional income elasticity coefficients differs significantly from zero. In respect to other explanatory variables, the striking feature is that several of the elasticity coefficients which are acceptable in a statistical sense carry wrong signs and hence appear unsuitable for evaluating import behavior. In addition to factors already mentioned, their inadequacy as well as that of national income probably stems from the fact that no account could be taken of (a) the simultaneity in the determination of the supply and demand for various oils and fats products, (b) counterbalancing changes in the importation of oilseeds, and (c) export availabilities in the associated overseas areas of member countries.

Summary and Conclusions

1. Food expenditure responsiveness with respect to changes in national income and based on data in constant dollars was most pronounced for imports obtained from Asia, South America, and intra-OEEC sources. These estimates indicate that for the period 1951-1960 a 1-percent increase in national income was associated with a 1.6- to 2.1-percent increase in food imports from these areas. By contrast, the income elasticities relating to food imports obtained from other regions, including that of the United States, were either substantially lower or carried a negative sign. On the whole, food imports from these regions may remain stationary or

Table 7. — Oils and Fats (SITC Section 4): Estimates of Import-Expenditure Elasticities With Respect to Selected Economic Variables, 1951-1960

Area or origin	Type of data[a]	Effect on OEEC imports of a 1-percent change in[b]			
		X_2	X_{126}	X_{139}	Exports[e]
World	a	0.37 (0.29)	1.16 (0.61)	0.96[c] (0.25)	([f])
	b	0.77[d] (0.29)	0.99[d] (0.42)	0.75[c] (0.18)	([f])
Intra-OEEC	a	0.36 (0.37)	1.11 (0.79)	0.65 (0.46)	([f])
	b	0.39 (0.40)	−0.09 (0.24)	0.50 (0.41)	([f])
OEEC excluding EEC and European Sterling Area	a	0.68 (0.53)	1.27 (0.91)	0.80 (0.72)	([f])
	b	0.72 (0.68)	−0.14 (0.41)	0.85 (0.70)	([f])
South America	a	0.97 (0.77)	6.04[c] (1.62)	2.57[c] (0.65)	1.68[d] (0.68)
	b	([f])	([f])	([f])	([f])
Asia	a	−1.37 (1.08)	−0.88 (2.49)	0.98 (1.19)	−1.08 (0.70)
	b	−1.69 (1.48)	−0.42 (2.28)	0.73 (1.18)	−1.00 (0.68)
Oceania	a	−0.53 (0.44)	−1.06 (1.07)	−0.84 (0.59)	−1.09[d] (0.45)
	b	−0.47 (0.59)	−0.91 (0.99)	−0.85 (0.54)	−0.80 (0.43)
Eastern Europe	a	1.92 (1.12)	3.33 (2.39)	0.92 (1.13)	1.13[d] (0.46)
	b	3.42 (1.52)	3.22 (2.14)	0.98 (1.15)	1.27[d] (0.46)
European Sterling Area	a	−0.56 (0.67)	0.40 (1.41)	0.97 (0.62)	−0.39 (0.75)
	b	−0.16 (0.85)	0.65 (1.23)	0.83 (0.57)	0.20 (0.65)

[a] Where *a* refers to coefficients obtained from analyses based on current value data expressed in logarithms and *b* refers to coefficients obtained from analyses based on logarithms of data in constant (1953) dollars. For a definition of variables see Table 1, footnote a, and for country coverage of areas of origin, see Supplement Table A12.

[b] Numbers in parentheses beneath regression coefficients are their respective standard errors.

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[d] Coefficient differs significantly from zero at the 5-percent probability level. Coefficients without superscript do not differ significantly from zero at the 5-percent probability level.

[e] OEEC total exports to specified regional import sources.

[f] Not computed.

at best cannot be expected to grow at a rate much greater than the rate of population increase. The analyses yielded no conclusive evidence of the extent to which favorable price relationships and exports affected the magnitude of food imports.

2. Beverages and tobacco displayed an invariably positive as well as markedly higher degree of responsiveness with respect to national income (X_2) and exports than either foods or oils and fats. Among the regional import sources under consideration and based on constant value data, Eastern Europe, Central America, and OEEC, excluding EEC and European Sterling Area countries, showed the highest income elasticity (2.2 to 4.4) and Asia the lowest (0.9). The comparable figure for the United States is 1.3. Except for products from the European Sterling Area, changes in world average value indexes of exports of beverages and tobacco (X_{125}) appear to have exercised a rather weak influence on the magnitude of imports. On the

supposition that trade barriers currently in effect will be raised and foreign production both within Western Europe and in its associated overseas areas will expand, imports from the United States may be expected to rise concurrently although less than proportionately with national income.

3. Evidence as to the nature and degree of oils and fats import responsiveness to various economic stimuli appears somewhat uncertain. Excepting those pertaining to the United States and over-all imports (world), none of the income elasticity coefficients obtained can be classed as particularly reliable indicators of past or guides to the future course of events. The lack of statistical evidence of income, export, and price effects may be partly due to offsetting fluctuations caused by numerous economic and institutional factors not allowed for in the analyses. It is an open question then the extent to which such forces impaired the import-determining relevancy of national income in regard to transactions consummated with the United States. Because of the interchangeability in use on one hand and disparity in the degree of self-sufficiency between alternative oils and fats products on the other, future import patterns from the United States are expected to be conditioned more by interproduct price differentials maintained by means of governmental price-support and import-control policies than by changes in national income per se. All things considered, imports of oils and fats from the United States seem likely to continue to expand at a rate much more moderate than that which would be indicated by the estimated income elasticity coefficient.

For the supplement tables referred to in this article, see "Western European Import Propensities for Food, Beverages and Tobacco, and Oils and Fats, Statistical Supplement," Univ. Ill. Agr. Exp. Sta. Research Report AERR-60, available from the author.

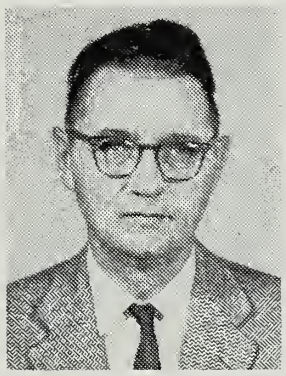
CONTRIBUTORS TO THIS ISSUE

L. A. DUEWER, a native of Morgan County, received his B.S. degree from the University of Illinois. After teaching vocational agriculture, he completed work for the M.S. degree at Illinois in 1962. He is at present a Ph.D. candidate at Iowa State University.

F. J. REISS is engaged in extension, research, and teaching in land economics and land tenure. He is the Illinois representative on the North-Central Regional Research Project, "Needed Adjustments in Land Tenure to Meet Changing Agricultural Conditions." He also teaches a course in farm appraisal.

L. P. FETTIG recently joined the staff as Assistant Professor of Agricultural Economics to undertake research and extension work on the economics of resource development. He received his Ph.D. from the University of Chicago after studying there on fellowships from Sears-Roebuck, Ford Foundation, and Federal Reserve Bank of Chicago.

R. P. SNODGRASS became interested in landlord-tenant relationships during the period when he was an assistant to the manager of the University Trust Farms. He received his M.S. degree in agricultural economics from the University of Illinois in 1963. He is now operating a grain and livestock farm in northwestern Illinois.



S. C. SCHMIDT received his early education at the University of Budapest and his Ph.D. degree from McGill University. Prior to coming to the University of Illinois, he was on the staff at the University of Kentucky and at Montana State College. His research is concentrated in the area of international trade.

UNIVERSITY OF ILLINOIS
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LOUIS B. HOWARD, Director

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